TISA (Time-Space Averaging) Update

D. Doelling

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TISA Team:

R. Bhatt, B. Lock, D. Morstad, C. Nguyen, M. Nordeen, R. Raju, M. Sun, H. Syed

SSAI

15th CERES-II Science Team Meeting
Newport News, VA, April 26-28, 2011

Outline

- GEO calibration update
- CERES prototype ordering tool improvements
- ISCCP-D2like and Flux-by-cloud-type products
- Surface flux validation
- GEO 1-hourly SW regional normalization
- Summary

GEO calibration update

- Recalibrate all GEOs to Aqua-MODIS between 2000-2011 over their respective life times to retrieve Edition4 GEO cloud properties
  - Currently (Edition2) piece wise (3-year increments) calibration coefficients are delivered
  - Radiometrically scale Terra 0.65μm radiance to Aqua-MODIS
  - Use Aqua as a reference and use Terra, desert and DCC to monitor stability of GEO's
  - Take into account spectral response differences using SCIAMACHY

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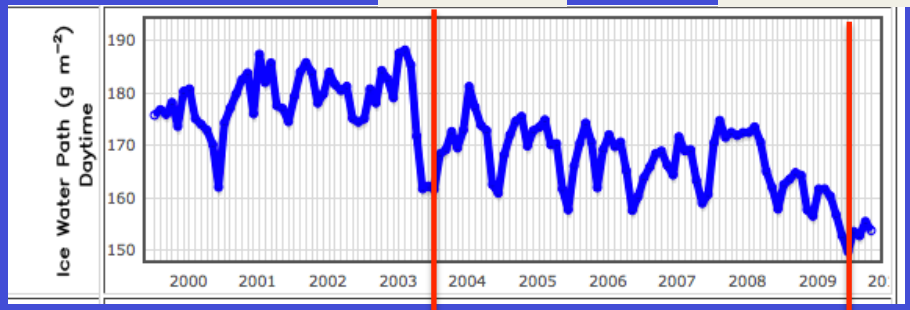
J. Xiong, A. Wu, *NASA GSFC*

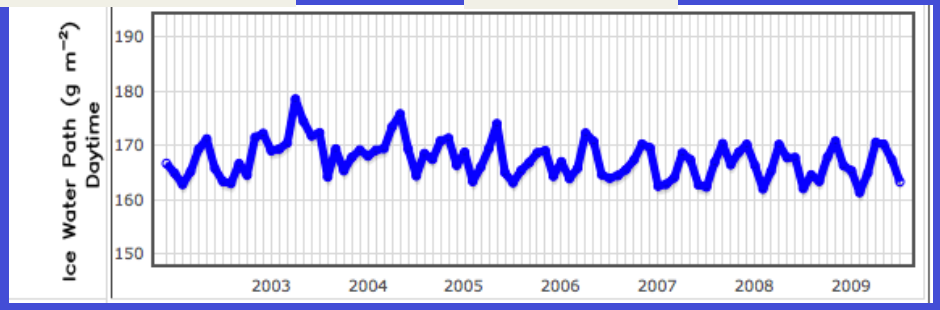
MODIS retrieved cloud properties

Terra

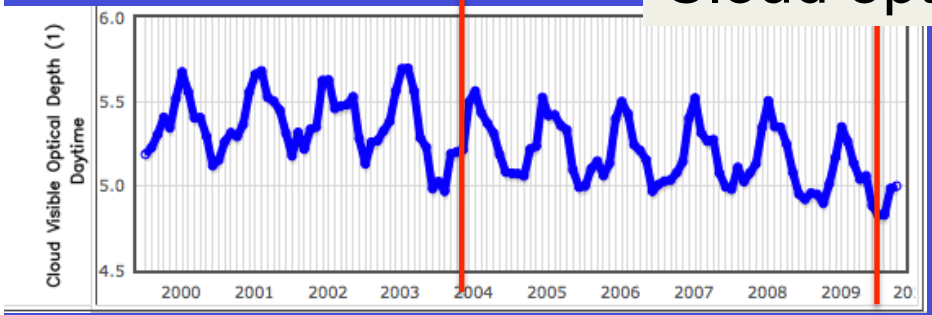
Ice Water Path

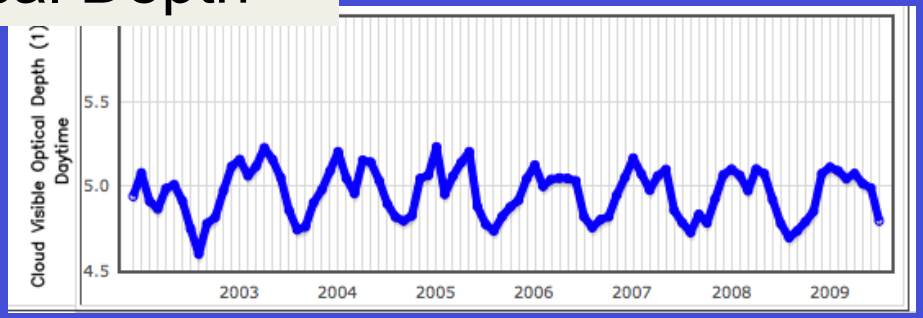
Aqua





Cloud optical Depth

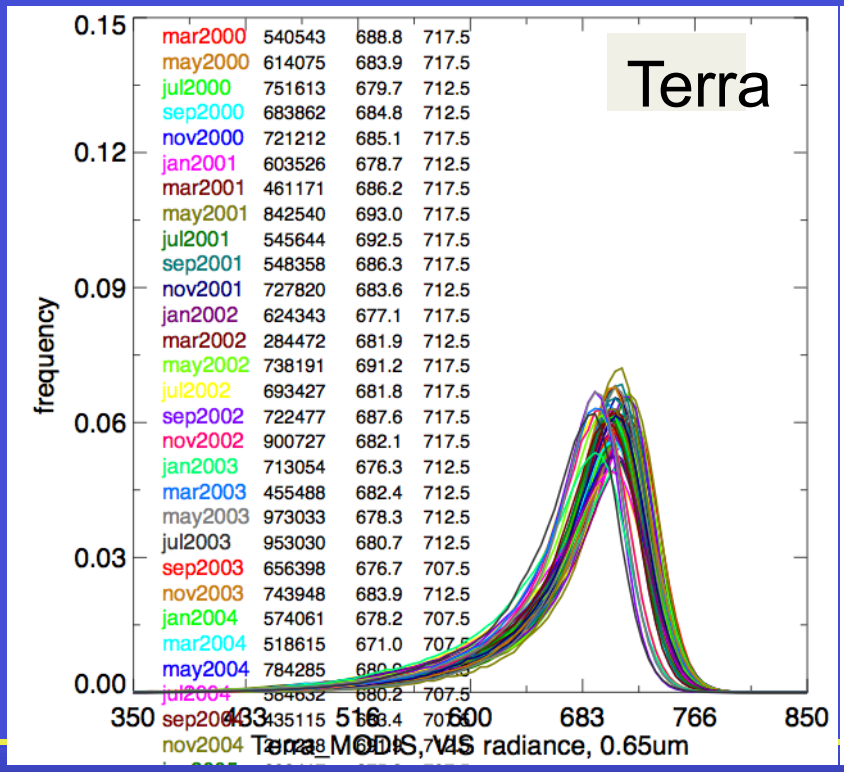


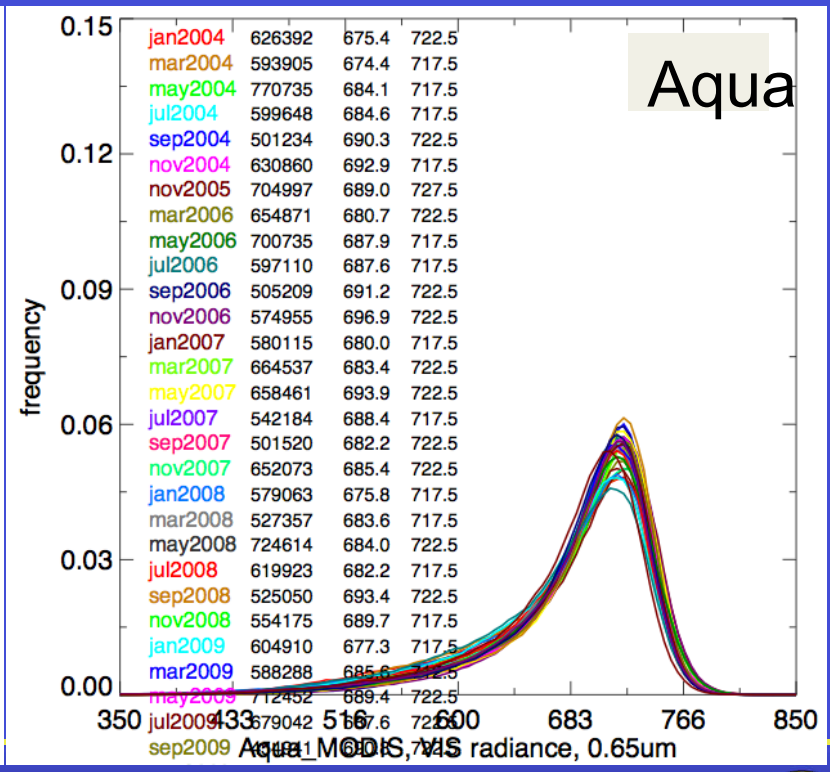


- Jack Xiong indicated 2 Terra MODIS instrument anomalies occurred on July 2003 and April 2009
- There is a downward trend in the IWP and optical depth derived from Terra, but not from Aqua

Terra and Aqua MODIS DCC trends

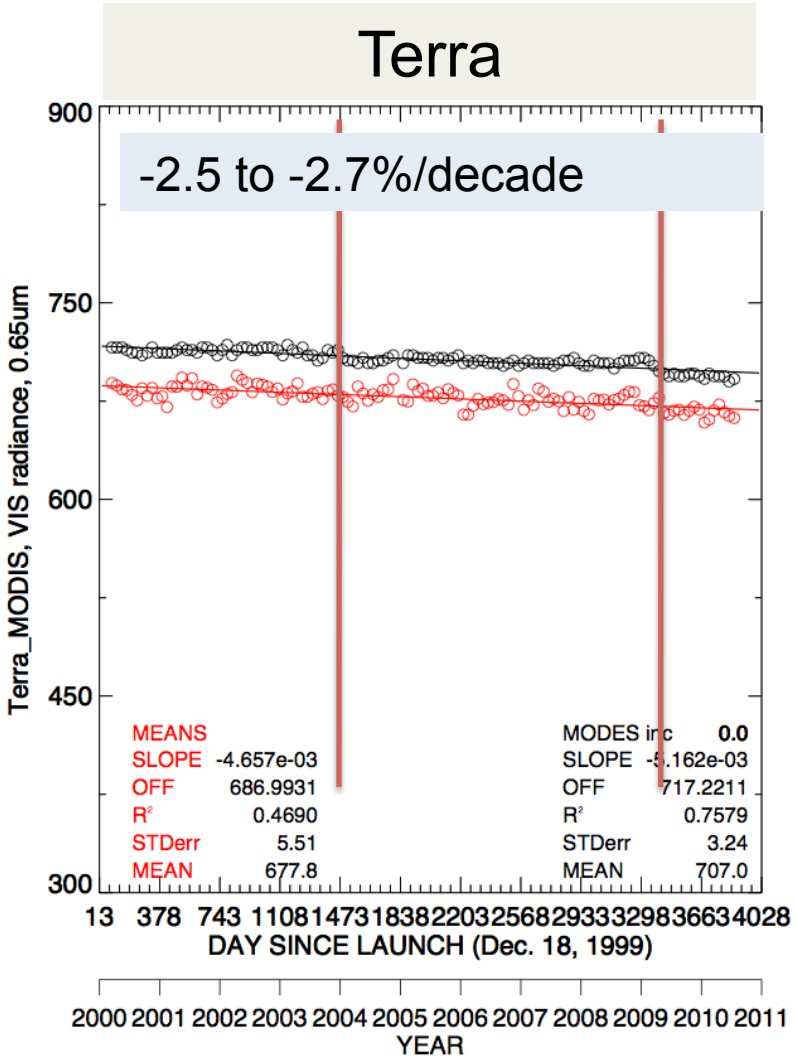
- Methodology: perform monthly PDFs of the Band 1 (0.65μm) radiances from pixels with 30°S<Lat<30°N, SZA<40°, VZA<40°, T(11μm)<205°K, σT(11μm) <1°K, σ (0.65μm)<3%
- Apply CERES DCC bidirectional model to convert radiance to overhead sun
- Use either the means or mode to track DCC radiances over time

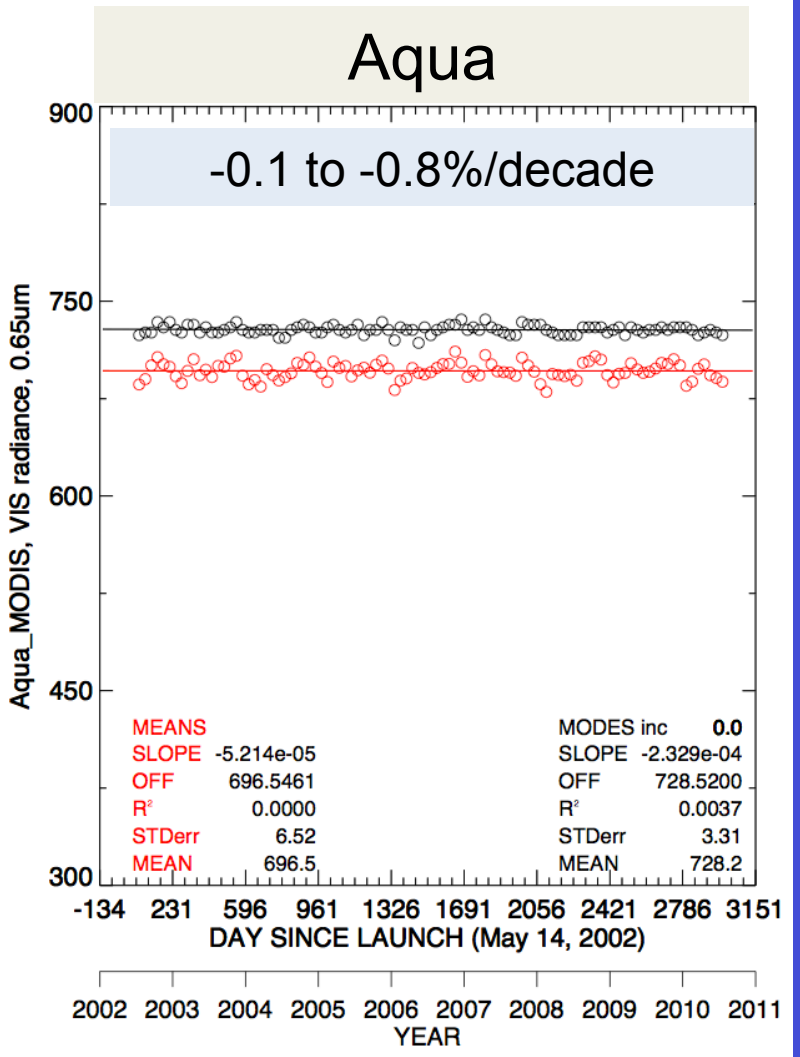




- Aqua_MODIS seems to be less noisy and more stable over time

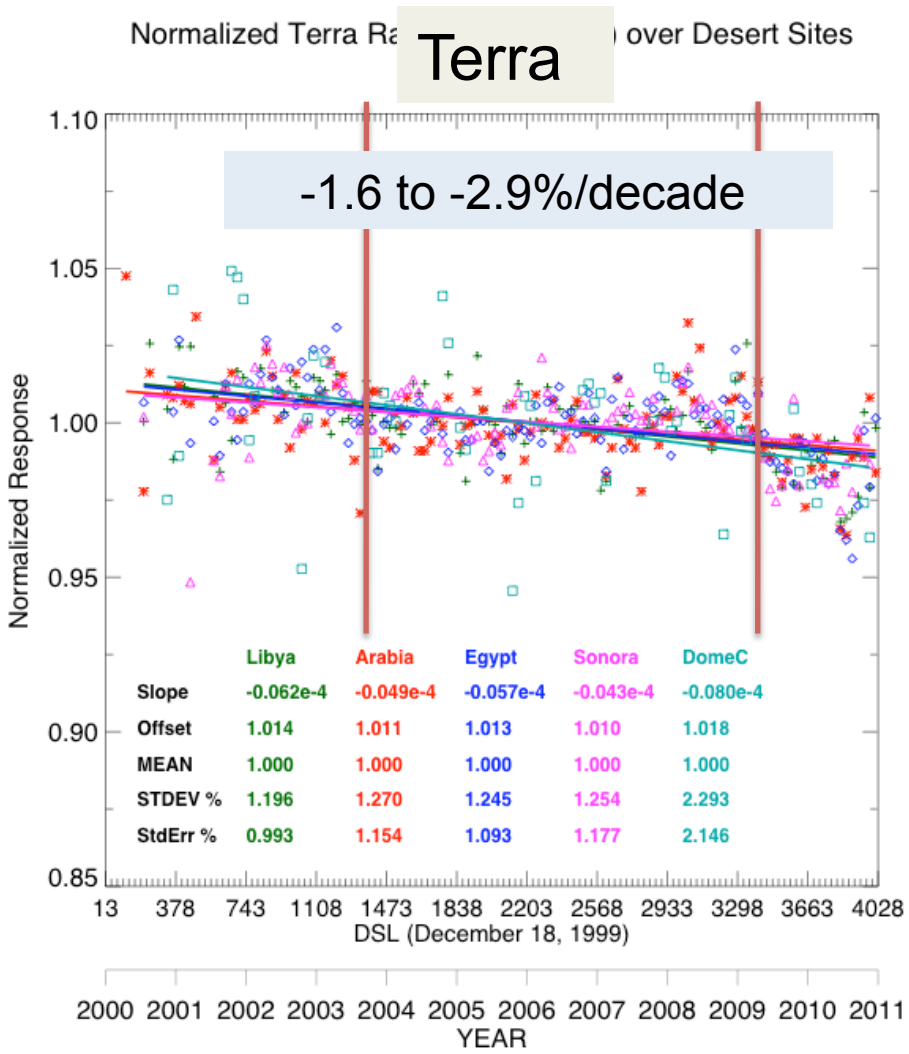
DCC

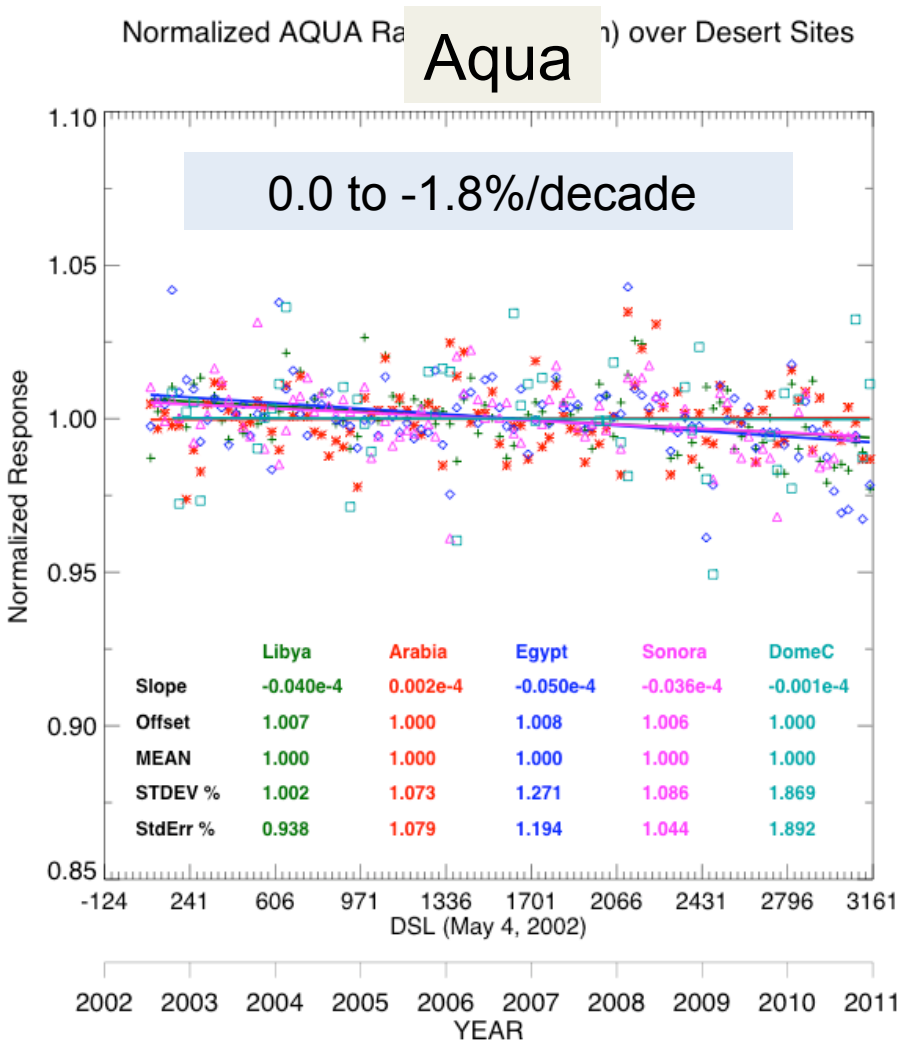




- Deep convective clouds (DCC) are stable invariant targets
- Terra DCC indicate a 2.7%/10years drop, and Aqua a 0.1%/10years drop
- Aqua band 1 is 3% brighter than Terra based on DCC

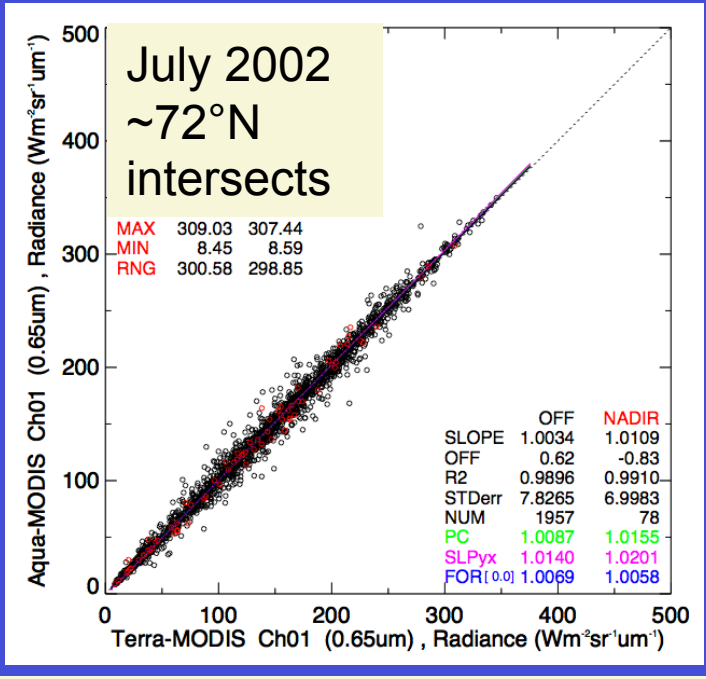
Desert

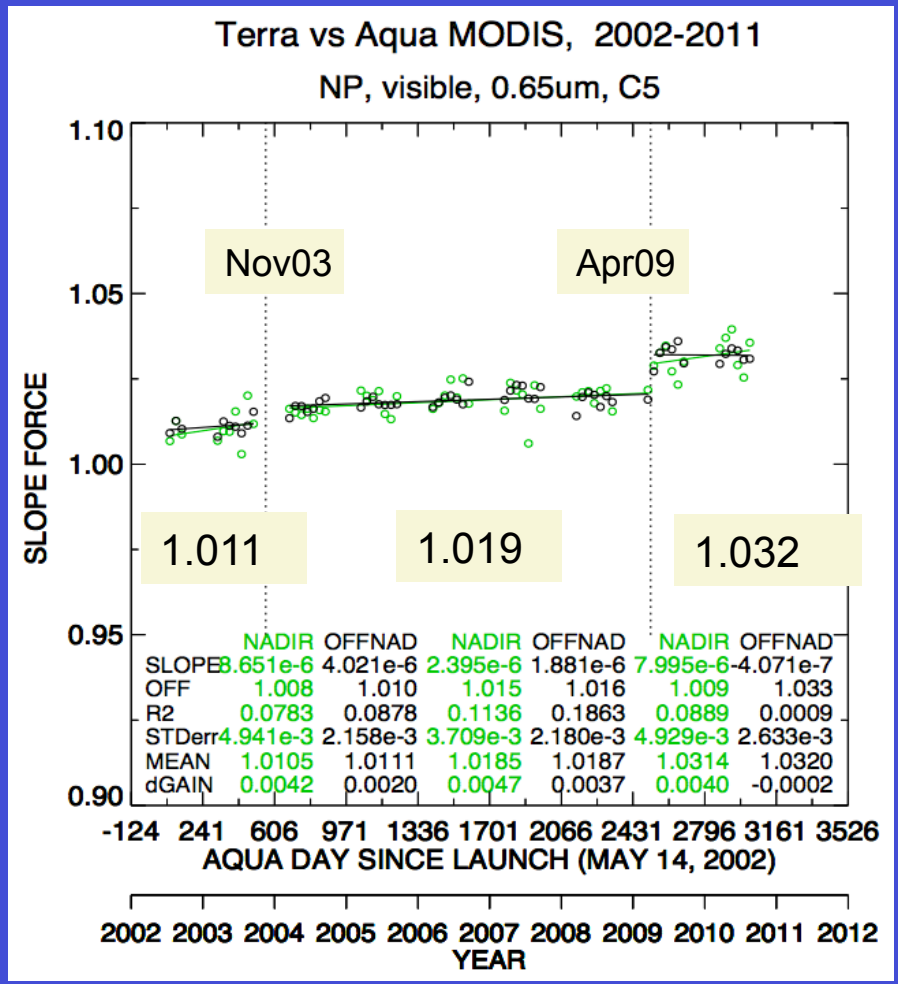




- Invariant deserts and snow targets indicate a 1.6 to 2.9%/10years drop for Terra and 0.0 to 1.8% drop for Aqua

Terra/Aqua SNO Collection 5



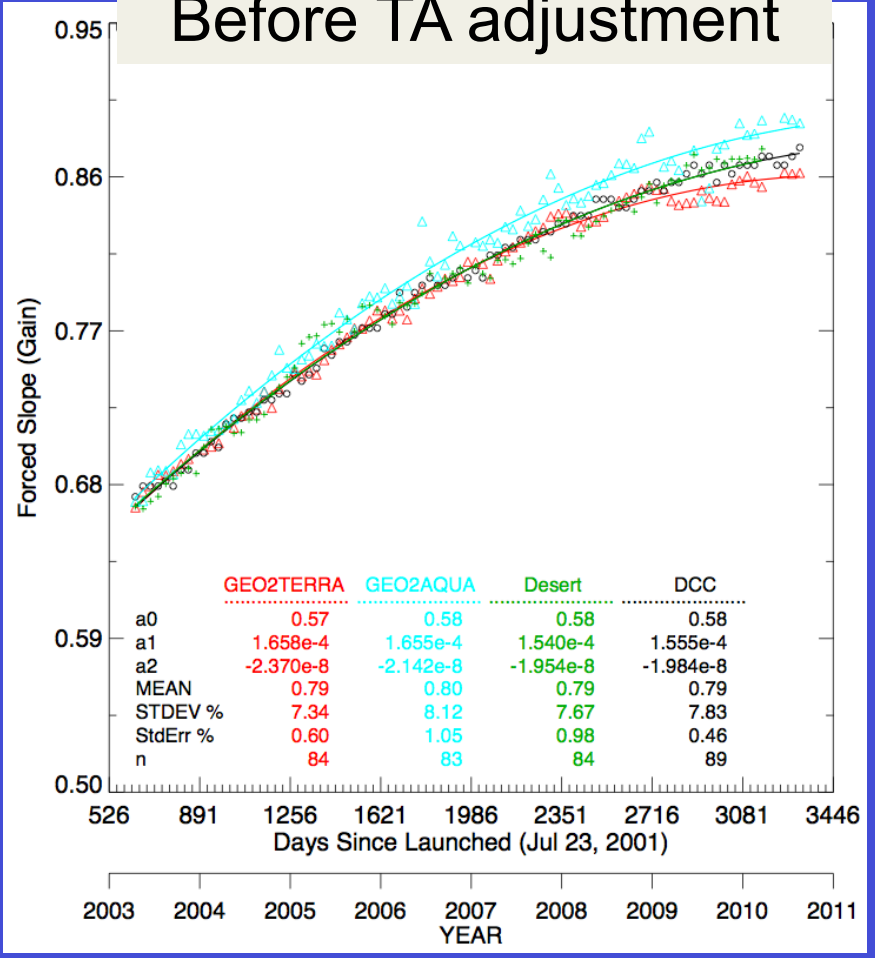


- Terra and Aqua simultaneous nadir radiance measurements (SNO)

- Use Aqua as a reference and tie Terra to Aqua for GEO calibration
- Factors to put on Terra-MODIS on the same radiometric scale as Aqua

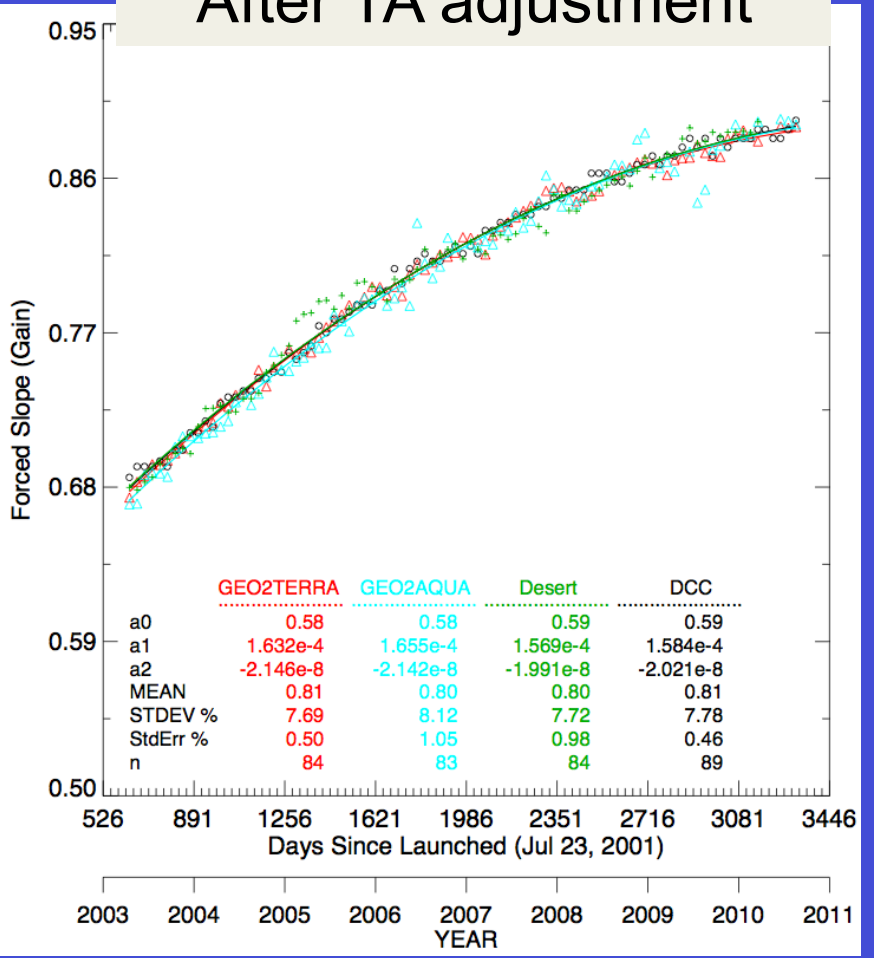
GOES-12 gain trend

Before TA adjustment



	GEO2TERRA	GEO2AQUA	Desert	DCC
a0	0.57	0.58	0.58	0.58
a1	1.658e-4	1.655e-4	1.540e-4	1.555e-4
a2	-2.370e-8	-2.142e-8	-1.954e-8	-1.984e-8
MEAN	0.79	0.80	0.79	0.79
STDEV %	7.34	8.12	7.67	7.83
StdErr %	0.60	1.05	0.98	0.46
n	84	83	84	89

After TA adjustment

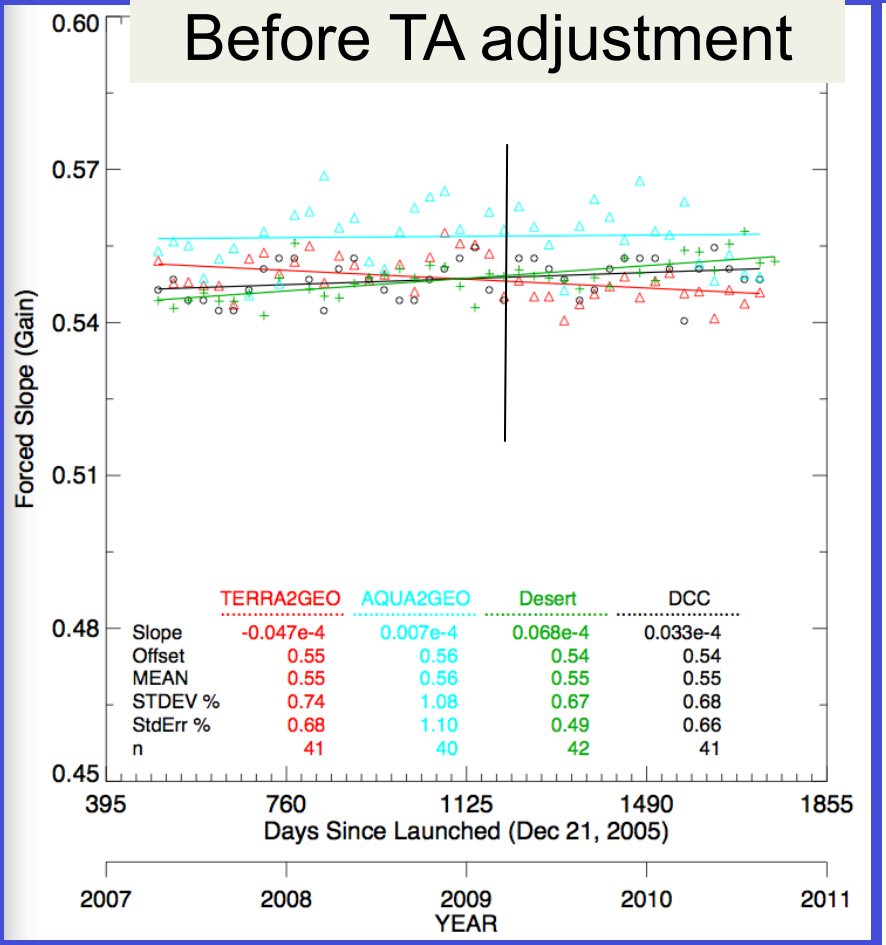


	GEO2TERRA	GEO2AQUA	Desert	DCC
a0	0.58	0.58	0.59	0.59
a1	1.632e-4	1.655e-4	1.569e-4	1.584e-4
a2	-2.146e-8	-2.142e-8	-1.991e-8	-2.021e-8
MEAN	0.81	0.80	0.80	0.81
STDEV %	7.69	8.12	7.72	7.78
StdErr %	0.50	1.05	0.98	0.46
n	84	83	84	89

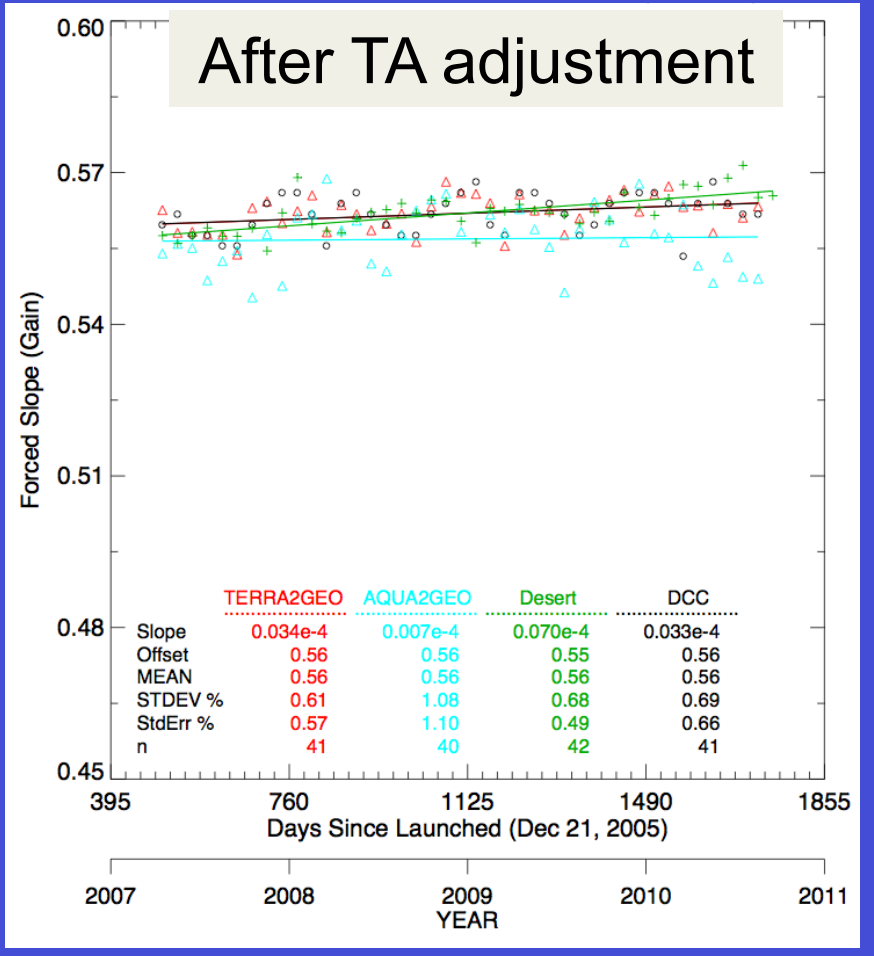
- DCC and deserts normalized to Terra ray-matching

Met-9 gain trend

Before TA adjustment



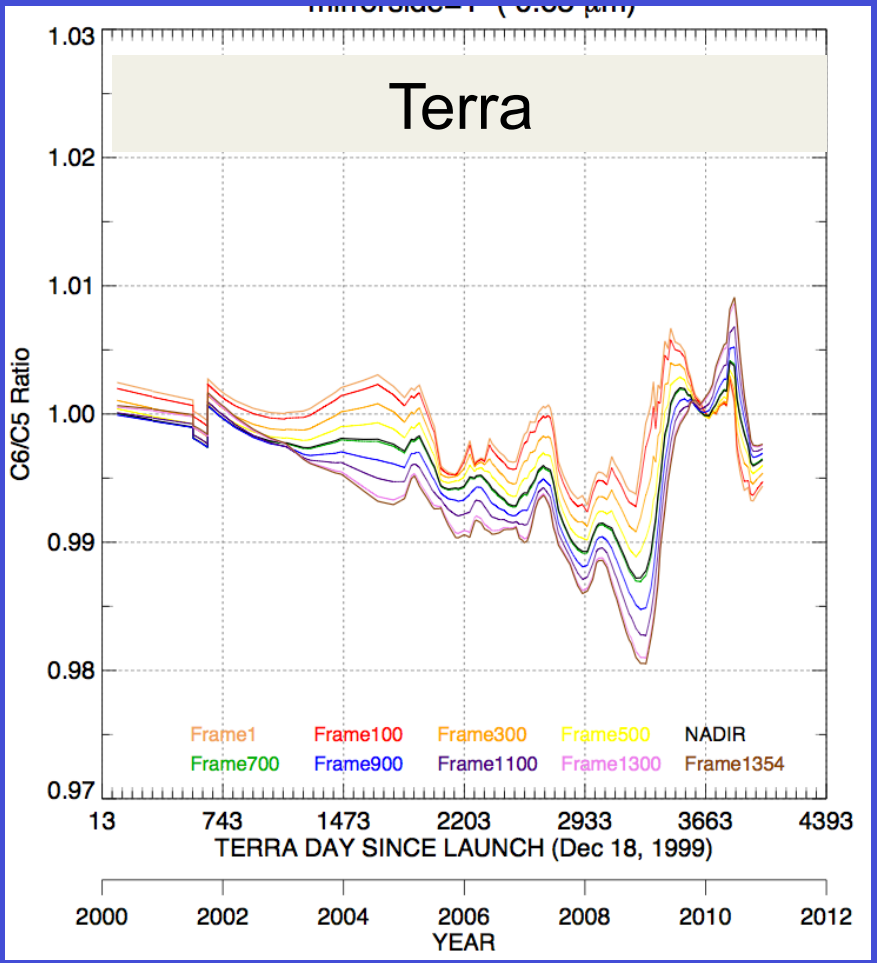
After TA adjustment

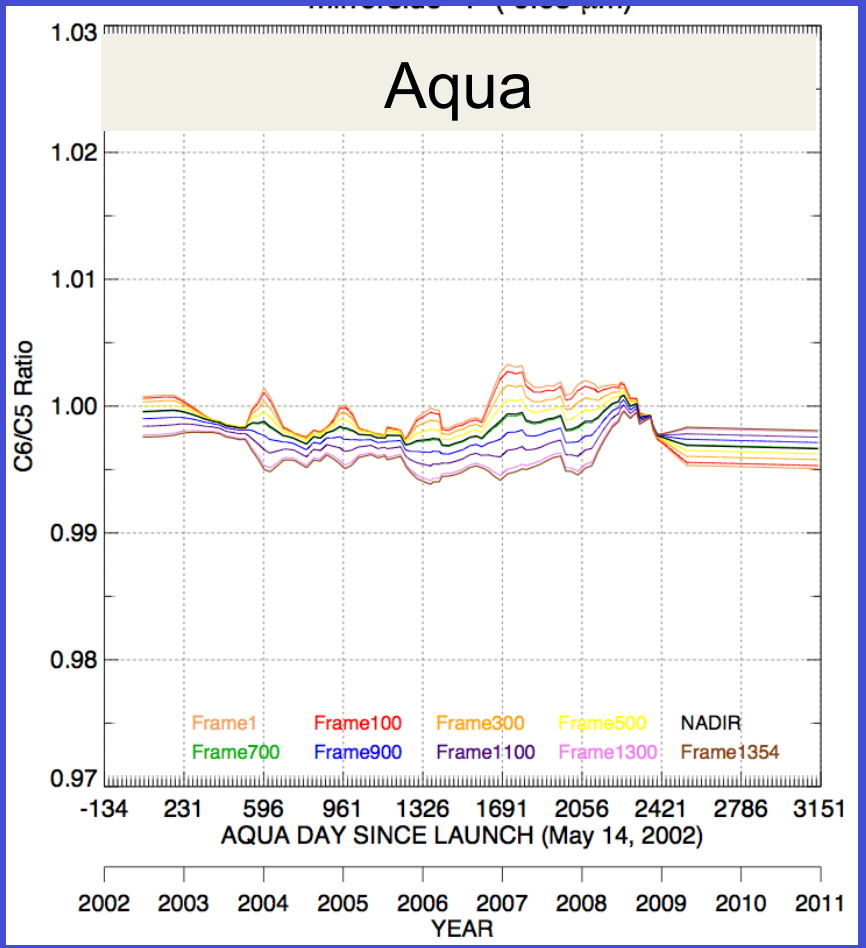


- Note that DCC and deserts have a different trend than Terra ray-matching

- Note the consistency between Terra, DCC and deserts

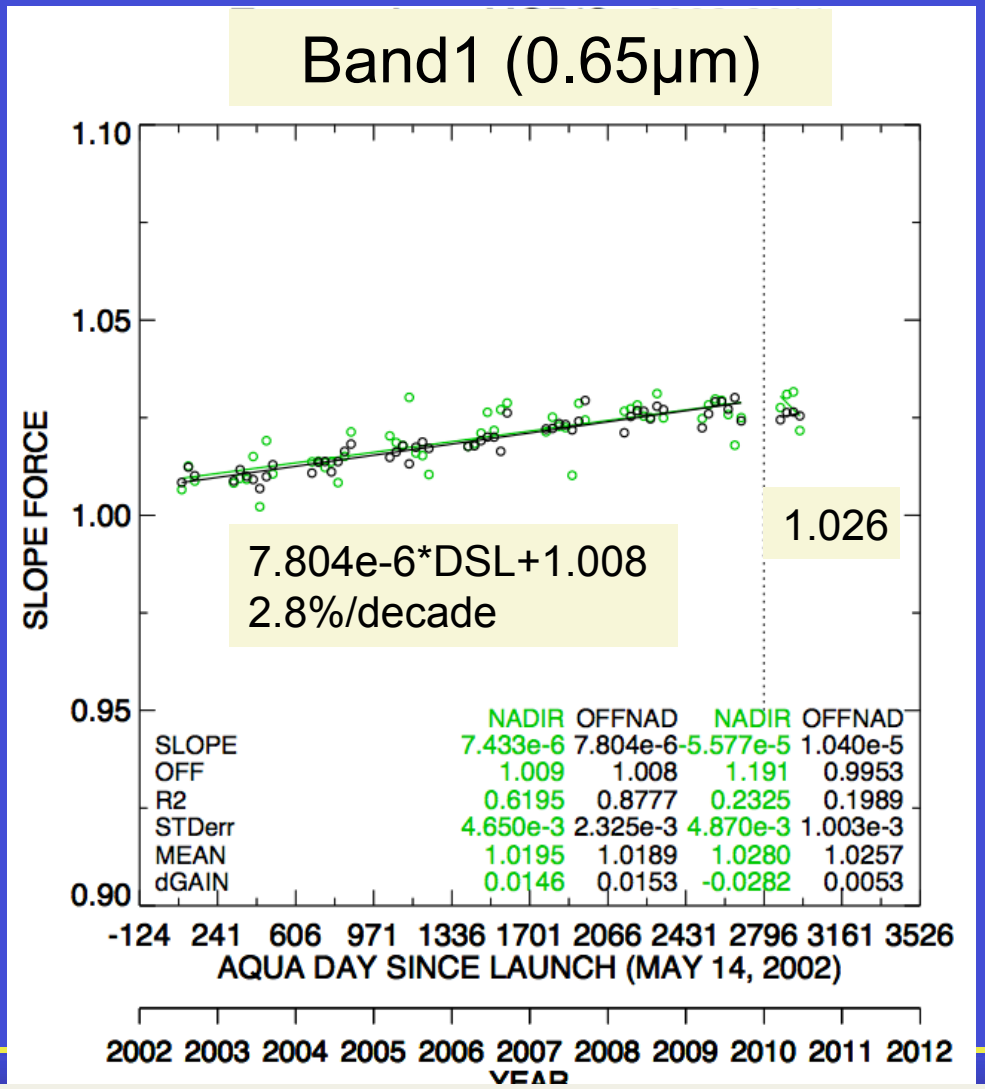
Scan angle dependencies correction factor to convert Collection 5 to 6





- The difference in correction factor across can be as great as 2%, typical 0.5%

Terra/Aqua SNO Collection 6



- Collection 6 will also Terra and Aqua relative calibration differences

CERES Prototype Ordering Tool

"Please excuse the fact that it's not really anything like the interface I just used of yours to get the CERES data!"
(User comment, April 12, 2011)

I do have one suggestion, which is that to be able to order data for one particular day, it would be nice to have the time range include the day of the month. As it is, I will have to download all the days in a month just to get on particular day (User comment, Jan 7, 2011)

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C. Chu, E. Kizer, C. Mitrescu, E. Heckert
SSAI

CERES Tiger Team

• CERES key concept or product web pages would be explained in a few bullets with expandable pages and hyper-links for more information, instead of the DQS approach which overwhelmed the user
• Every page designed to help the user quickly decide the product for their application, user realizes there are multiple spatial, temporal and algorithm differences for a given parameter

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J. Corbett*, Z. Eitzen*, E. Kizer*, J. Norris,
D. Rutan*, P. Taylor[a], T. Wong[a]
**SSAI, [a]NASA LaRC*

• Always looking for new volunteers, ideas and critique of pages

Order tool statistics (May2010-Apr2011)

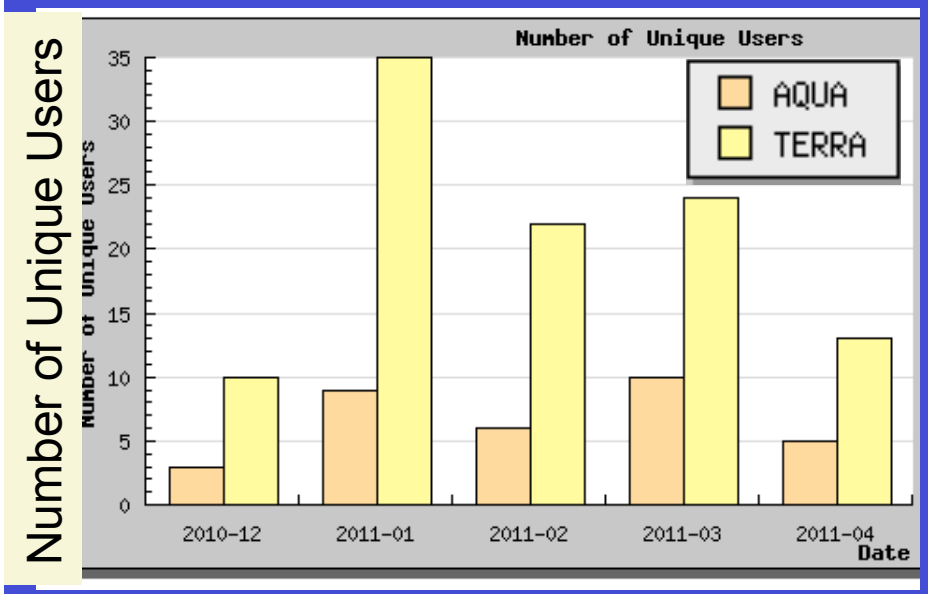
- Number of unique users (email) 136 that ordered
- Number of unique users (IP addresses) 272 that browsed or ordered

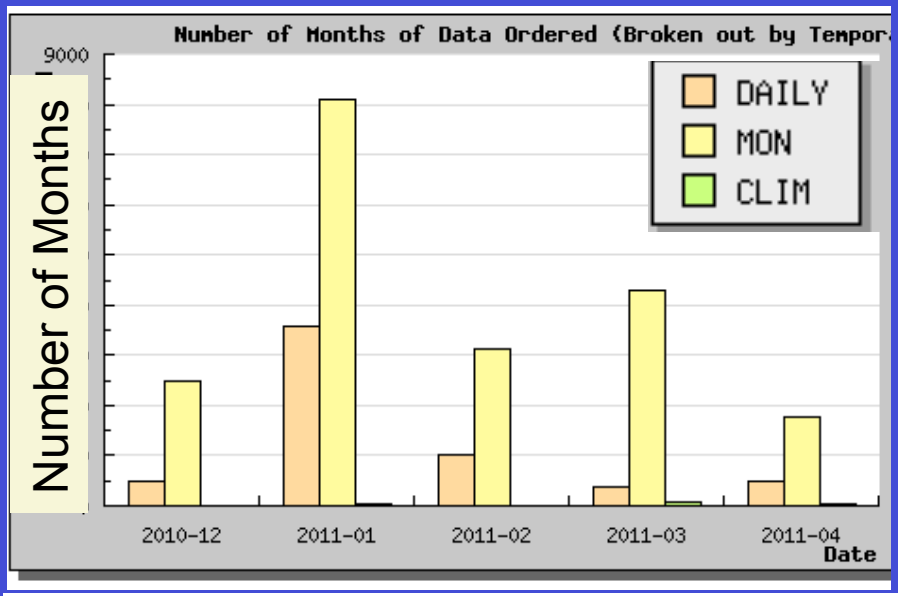
	Orders	Files	Months	Subset (GB)	HDF* (TB)	Subset/ HDF
EBAF	138	138	10.5K	9		
SSFlite	229	302	18K	145	4.4-13.2	1-3%
SYNlite	227	313	16K	144	3.9-11.7	1-3%

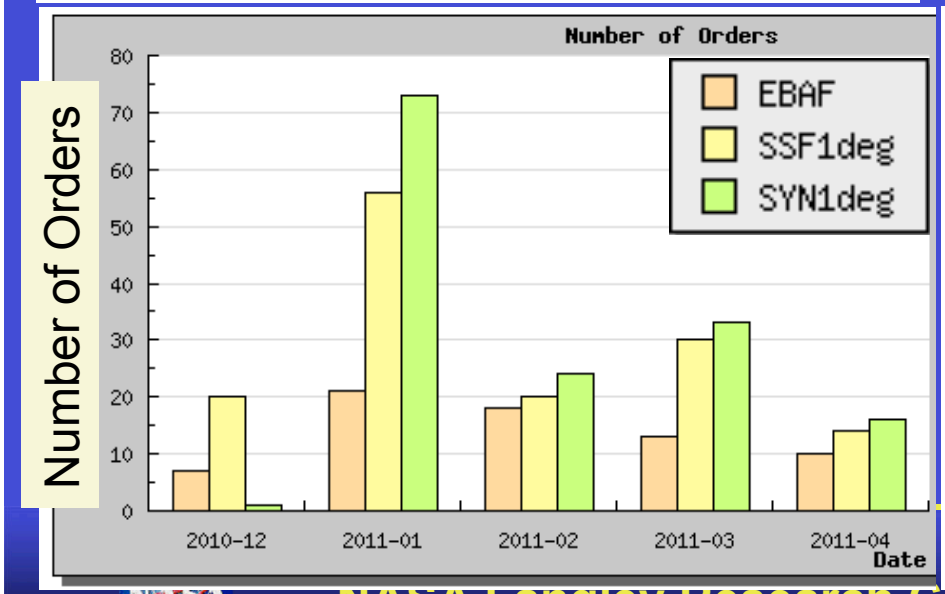
* Depends on whether monthly, daily or TOA, or cloud properties were ordered

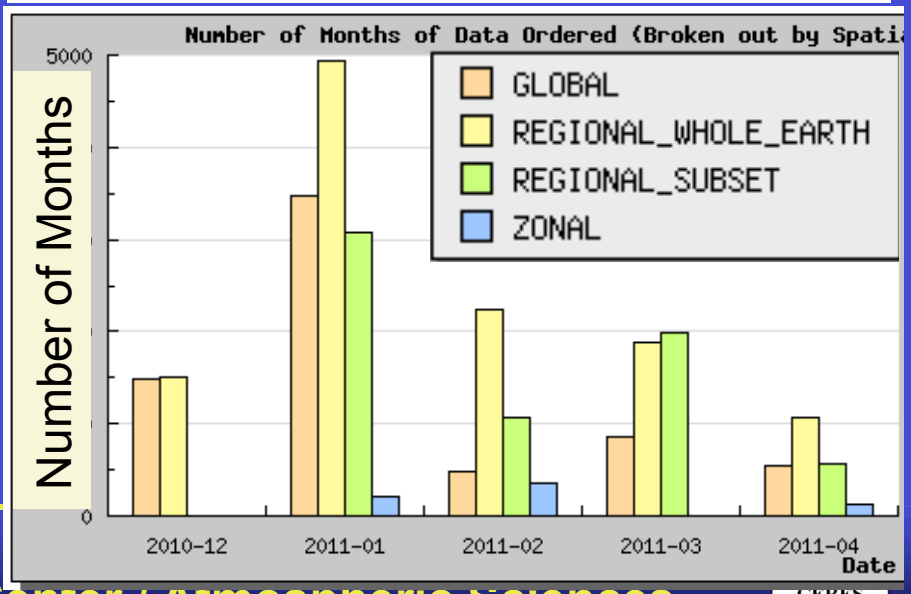
- Users only grab the parameters they want

Ordering Tool Statistics







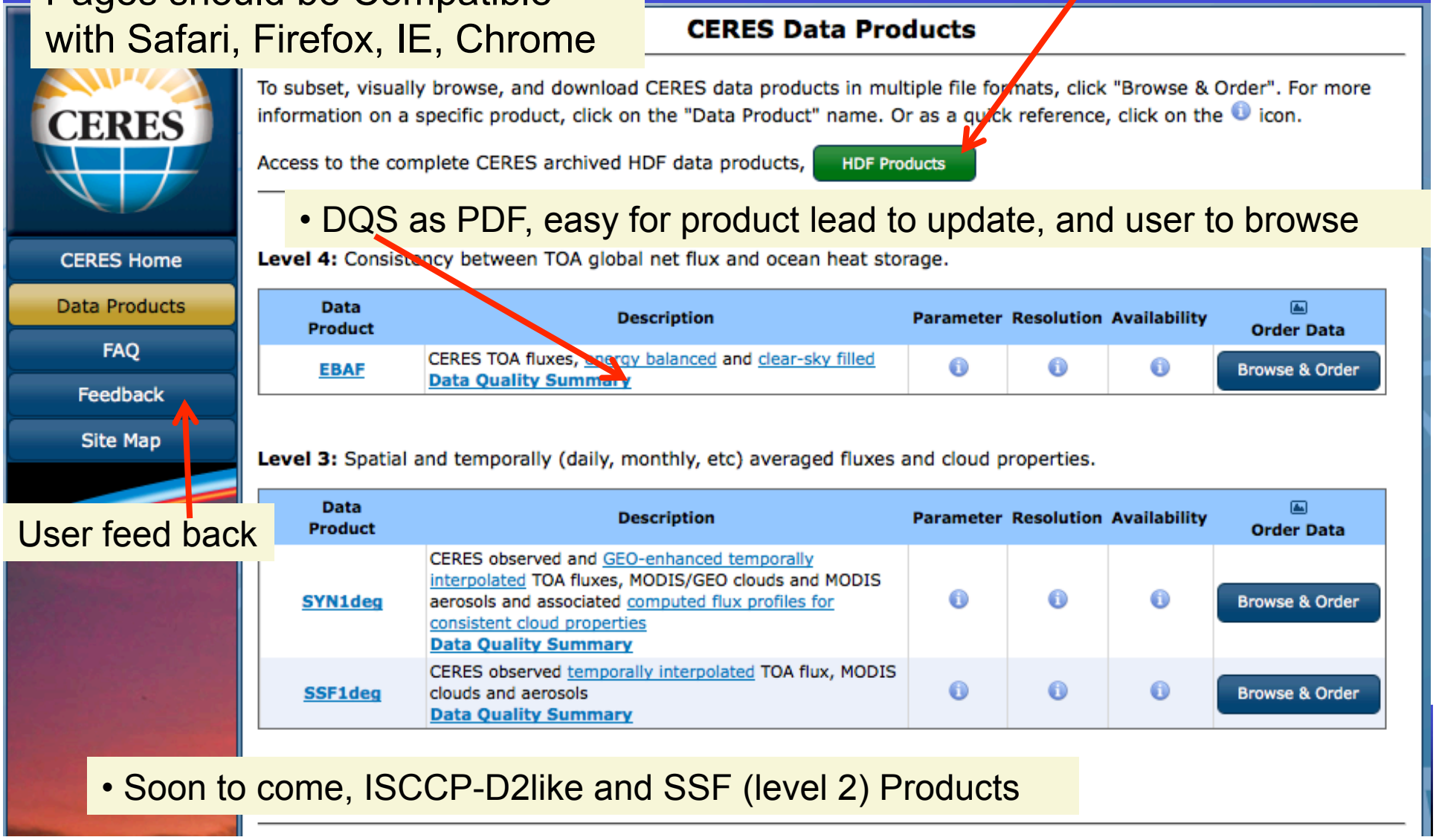


CERES subset, browse and order the latest Edition Products PAGE

http://ceres.larc.nasa.gov

Pages should be Compatible with Safari, Firefox, IE, Chrome

CERES archived HDF Data Products, all Editions, products, instruments, etc, PAGE



User feed back

• Soon to come, ISCCP-D2like and SSF (level 2) Products

CERES Archived HDF Data Products

To subset, visually browse, and download data in netCDF format, Browse & Order

CERES archived HDF Data Products, all Editions, products, instruments, etc, PAGE

Back to subset and browse of latest Edition products

Data Products

Product Info

Level 3: Spatial and temporally (daily, monthly, etc) averaged fluxes and cloud properties.

Data Product	Description	Parameter	Resolution	Availability	Order Data
SYN/AVG/ZAVG	3-hourly (SYN), monthly mean (AVG/ZAVG) computed surface and in-atmospheric fluxes consistent and along with the CERES observed fluxes and clouds.				Order via ASDC
SRBAVG	Monthly mean observed top of the atmosphere (TOA) fluxes and clouds with parameterized surface fluxes for GEO-enhanced and CERES-only temporally interpolated.				Order via ASDC
SFC	Instantaneous footprint gridded means of flux and cloud parameters from the SSF product.				Order via ASDC
FSW	Instantaneous footprint gridded means of computed flux and observed cloud parameters from the CRS product.				Order via ASDC
ISCCP-D2like	Monthly 3-hourly (GMT based) and monthly mean cloud properties stratified by ISCCP cloud types and in the similar D2 format.				Order via ASDC
FLASH_TISA	Near real-time observed TOA fluxes and clouds with parameterized surface fluxes, not officially calibrated for publication.				Order via ASDC
ES4/ES9	Instantaneous gridded (ES9) and monthly (ES4) mean TOA fluxes using algorithms identical to those used by ERBE.				Order via ASDC

Order Product

Level 3

Parameter, Resolution, Availability

Level 2: CERES instantaneous footprint level fluxes and cloud properties.

Data Product	Description	Parameter	Resolution	Availability	Order Data
SSF	CERES observed TOA flux, MODIS clouds and aerosols and parameterized surface fluxes		FOV*		Order via ASDC
CRS	Computed flux profiles from MODIS clouds and aerosols		FOV*		Order via ASDC
FLASH_SSF	Near real-time SSF product, not officially calibrated for publication		FOV*		Order via ASDC
CERES-MISR	Nadir view CERES-SSF/MODIS/MISR collocated parameters		FOV*		Order via ASDC
CCCM	Nadir view CERES-SSF/MODIS/CALIPSO/CloudSat collocated parameters		FOV*		Order via ASDC
ES8	CERES observed TOA fluxes using original ERBE algorithms		FOV*		Order via ASDC

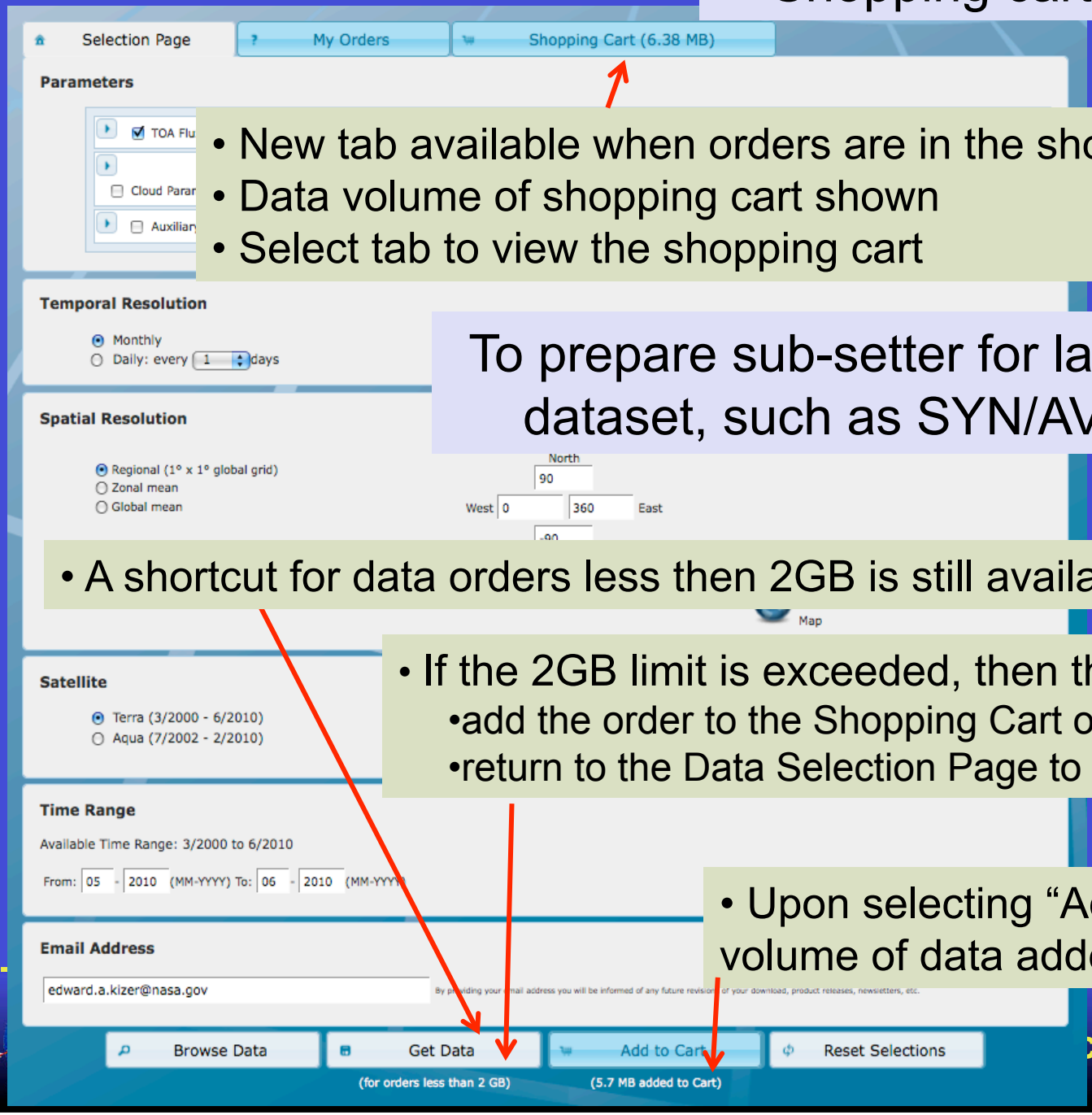
Product Description

Level 2

ric Sciences

CERES

Shopping cart pages



- New tab available when orders are in the shopping cart
- Data volume of shopping cart shown
- Select tab to view the shopping cart

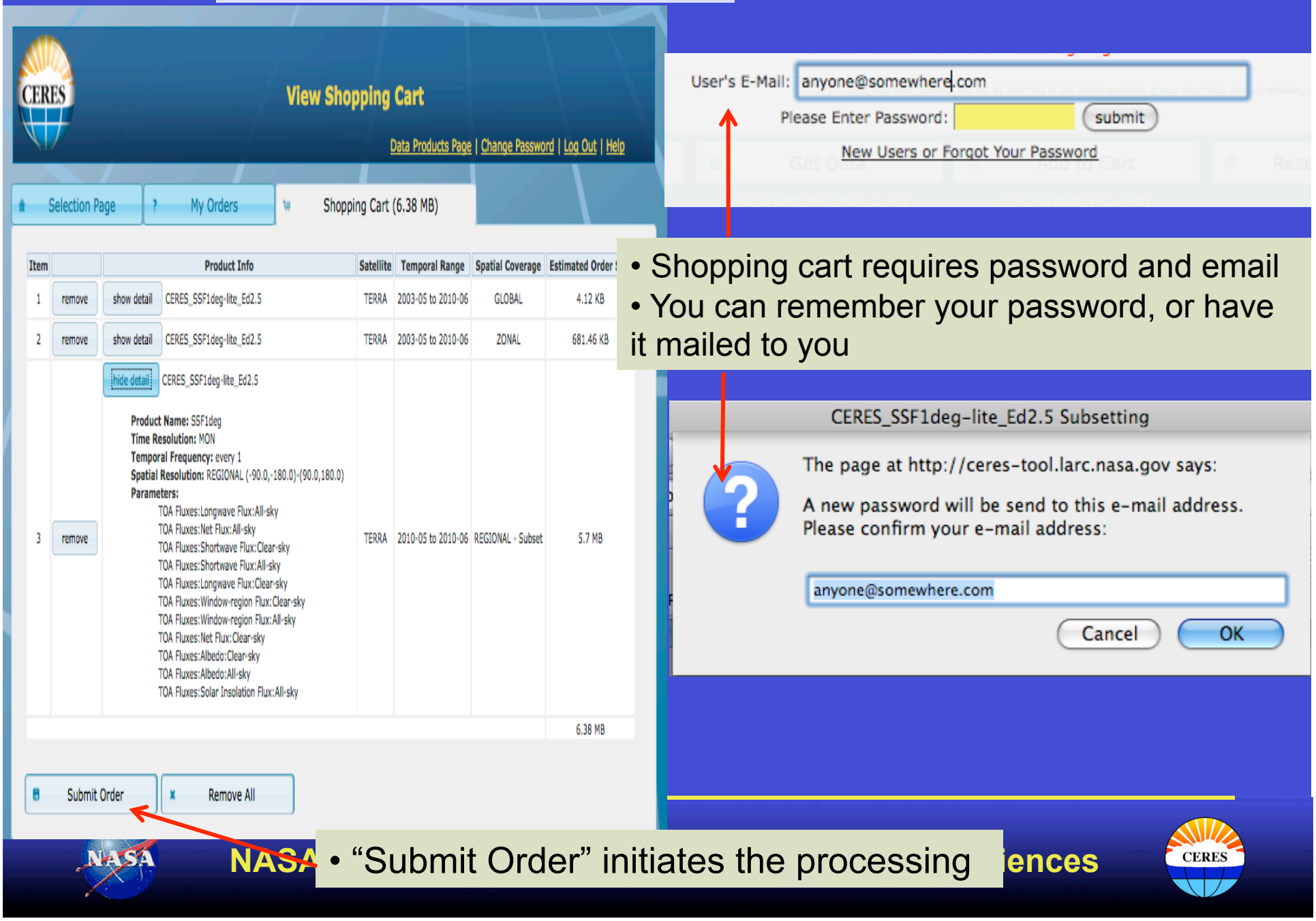
To prepare sub-setter for large volume dataset, such as SYN/AVG/ZAVG

- A shortcut for data orders less then 2GB is still available

- If the 2GB limit is exceeded, then the options are:
  - add the order to the Shopping Cart or
  - return to the Data Selection Page to modify the order

- Upon selecting “Add to Cart”, the volume of data added is show below

Shopping cart pages



- Shopping cart requires password and email
- You can remember your password, or have it mailed to you

- "Submit Order" initiates the processing

Shopping cart pages

Report

Monitor the processing after order has been submitted

Your order
Your order number is: CERES_2011-04-20:30
You will be notified by email when your order is completed.
You can check the status of your orders at any time by using our Order Status function (click here).
Thank you for using our CERES Ordering Tool.

Selection Page | My Orders

Order Status

Order Name	Submitted On	Expires On	Status
CERES_2011-04-20:30	2011-04-20 10:30:30.0	2011-04-22	done

Selection Page | My Orders | Order Status

Order CERES_2011-04-20:30 Status

Item	Product Info	Satellite	Temporal Range	Spatial Coverage	Order Status	Number Of Files	Completed Files	Processing Files	Failed Files	Order Size	Estimated Order Size
1	CERES_SSF1deg-lite_Ed2.5	TERRA	2003-05 to 2010-06	GLOBAL	done	1	1	0	0	9.22 KB	4.12 KB
2	CERES_SSF1deg-lite_Ed2.5	TERRA	2003-05 to 2010-06	ZONAL	done	1	1	0	0	687.51 KB	681.46 KB
3	CERES_SSF1deg-lite_Ed2.5	TERRA	2010-05 to 2010-06	REGIONAL - Subset	done	1	1	0	0	5.71 MB	5.7 MB
										6.4 MB	6.38 MB

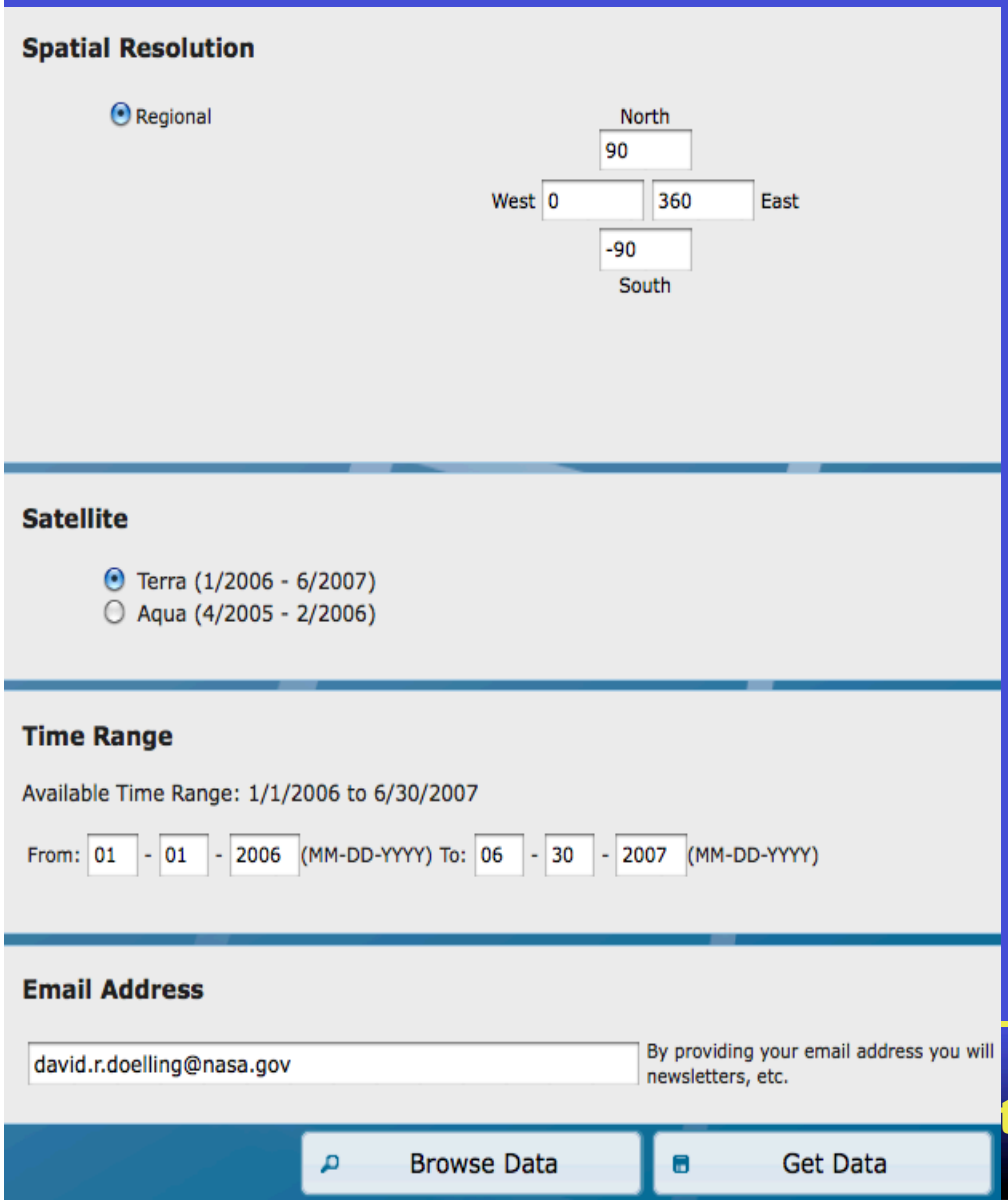
SSF (level 2) sub-setting (to be released shortly)

Parameter selection, not all parameters offered

Parameters

Time/Location /Angles	Selected Fields: None		
CERES Observed TOA Fluxes and Radiances		Fluxes	Radiances
	CERES TOA Shortwave	☐	☐
	CERES TOA Longwave	☐	☐
	CERES TOA Window	☐	☐
Surface Fluxes	Selected Fields: None		
Surface Parameters	Selected Fields: None		
GEOS-5 Atmosphere Parameters	Selected Fields: None		
Cloudy Footprint Area	Selected Fields: None		
MODIS Land Aerosols	Selected Fields: None		
MODIS Ocean Aerosols	Selected Fields: None		

SSF (level 2) sub-setting



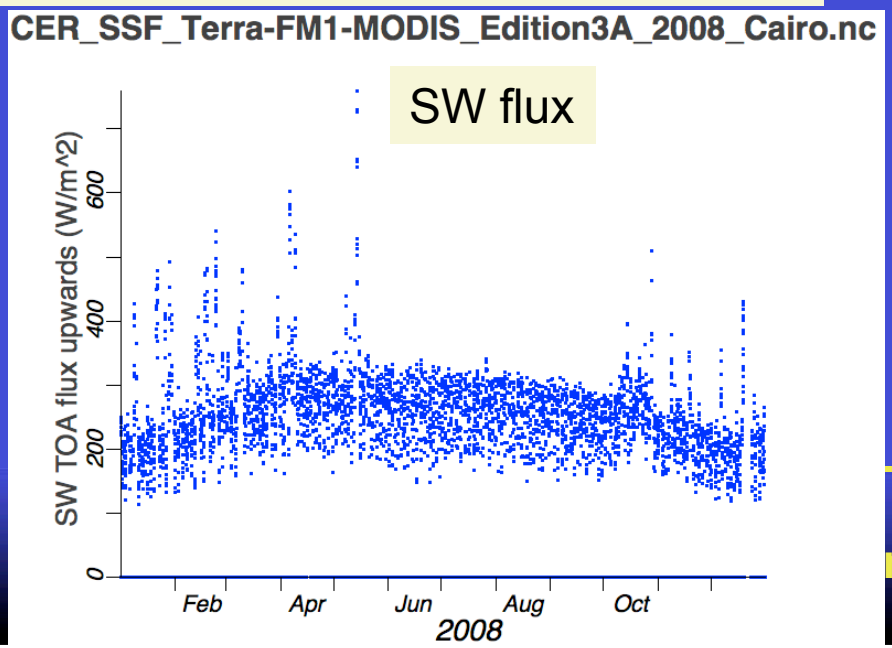
- The HDF sub-setted parameters and location will be written out in netCDF

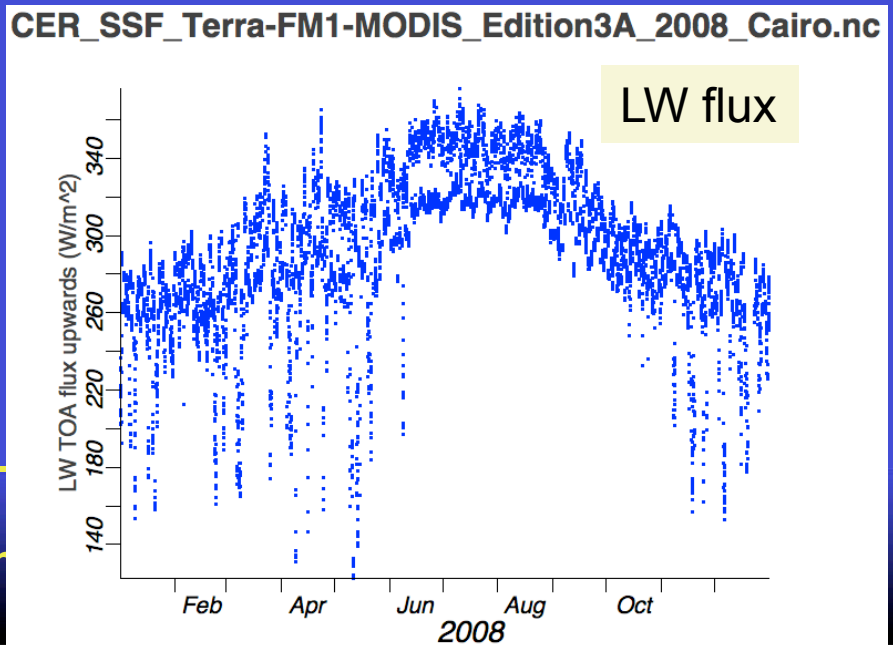
- Option to retain hourly SSF filenames in the netCDF files or to merge them into 2GB files ordered in time

SSF (level 2) site ordering

- Parameter Selection: SW,LW and WN flux
- Spatial Selection: Cairo lat and lon with a 30km radius
- Temporal Selection: all of 2008
- Result: One NetCDF file (0.4MB) of 730 footprints
- Time to order file: 25 minutes
- Traditional Way: ~0.5TB of 8760 HDF files (1250x more data)

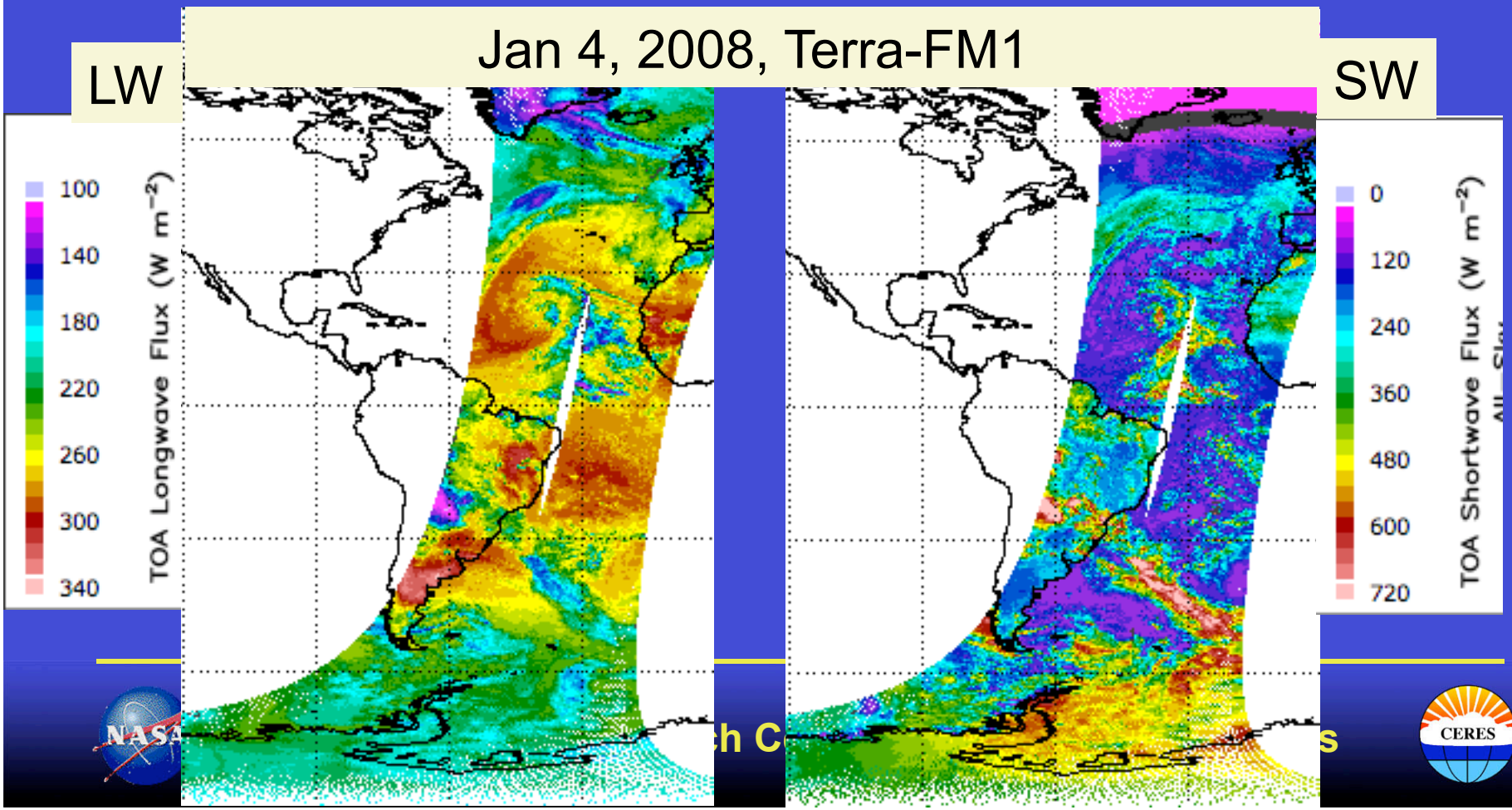
Courtesy of Walt Baskins (ASDC)





SSF level 2 plotting package

- To give the user an idea of what the data and CERES swath looks
- Map up to a day's worth of orbits of a single SSF parameter
- Work with DAAC to quickly transfer from DPO to browse package



CERES Ordering Tool Highlights

- Aug 2009 – Initial web pages designed and framework developed on MAC laptops
- Apr 2010 – Live demonstration of tool at CERES science team meeting
- Jun 2010 - 1 CPU machine installed @ building 1250 with Tool Version 1.0 serving SSF/SYN1deg-lite-beta data products in time for AMS radiation conference in Portland Oregon
- Aug 2010 – Newly redesigned CERES web pages go live, giving users access to tool and providing user oriented information
- Sept 2010 - 2 CPU machines and 40TB hardware being installed @ building 1268 and incorporating Edition 2.5 SSF/SYN1deg-lite and EBAF data products including daily parameters
- Oct 2010 –Tool Version 1.1 released for the A-train users workshop. The tool was highlighted to introduce new users to CERES data.
- Mar 2011 –Tool Version 2.0 released with shopping cart features.
- Apr 2011 – ISCCP-D2like, SSF (level 2) sub-setting soon to be added, integration of traditional HDF ordering pages, SYN/AVG/ZAVG next

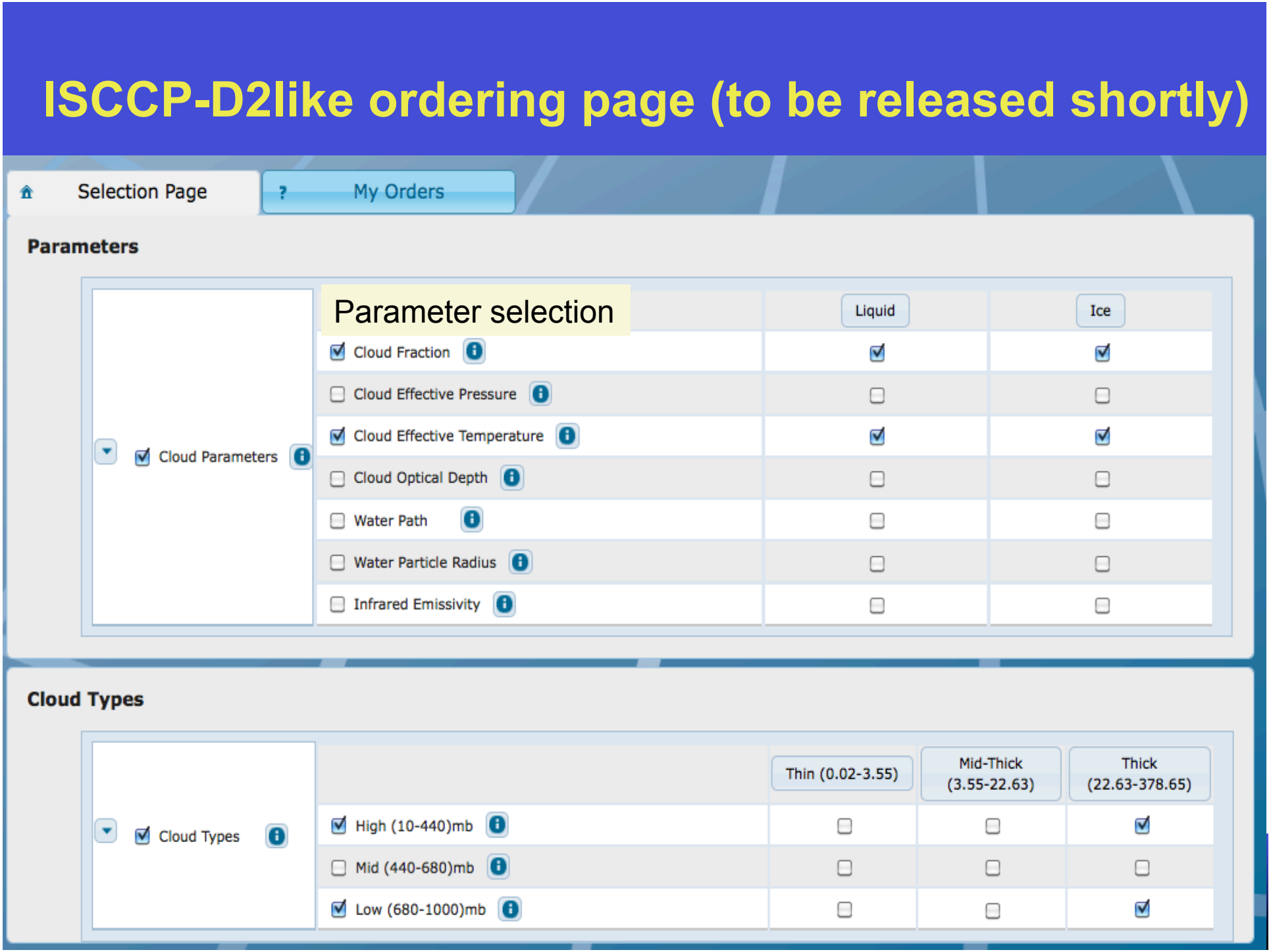
ISCCP-D2like and Flux_by_cldtype Products

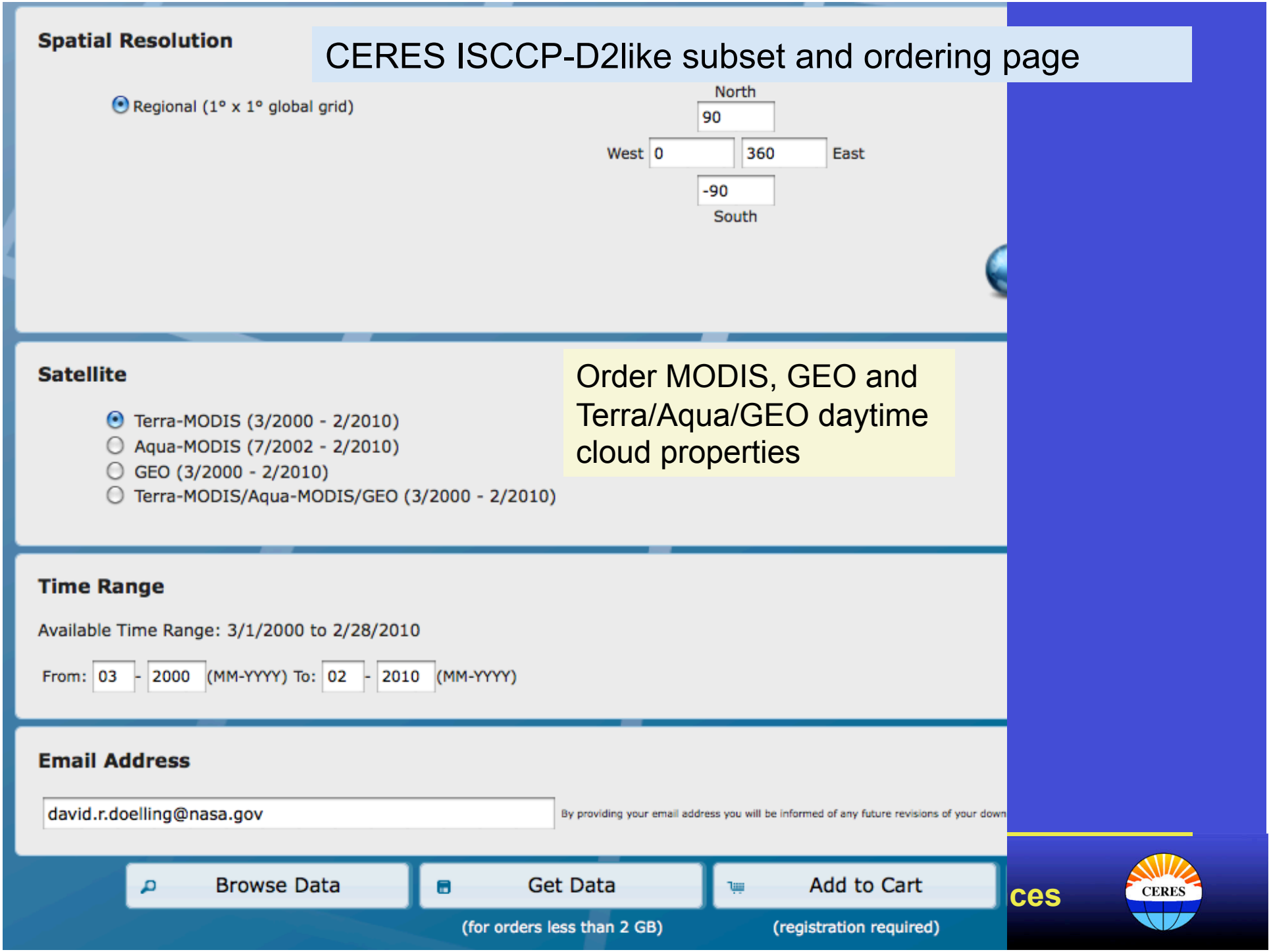
- Soon to put 10-years of ISCCp-D2like day, GEO, and Terra/Aqua/GEO product on sub-setter
  - Minor optical depth bug fixed, data has been reprocessed
- Flux by ISCCP cloud type beta product soon to be tested by Jason Cole
  - Instantaneous gridded fluxes by cloud type

D. Doelling, N. Loeb, *NASA LaRC*

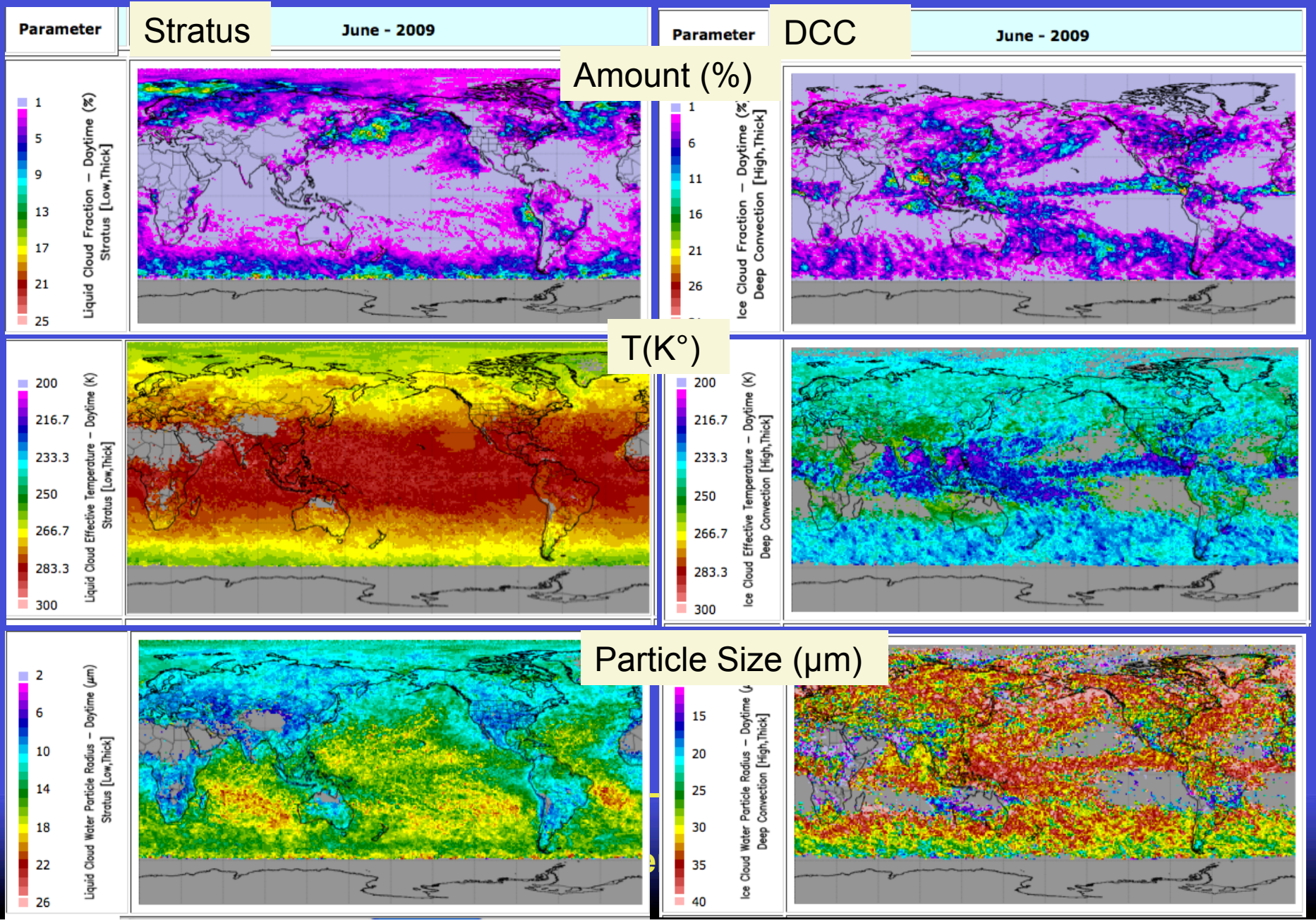
M. Sun, R. Raju, H. Syed, *SSAI*

ISCCP-D2like ordering page (to be released shortly)

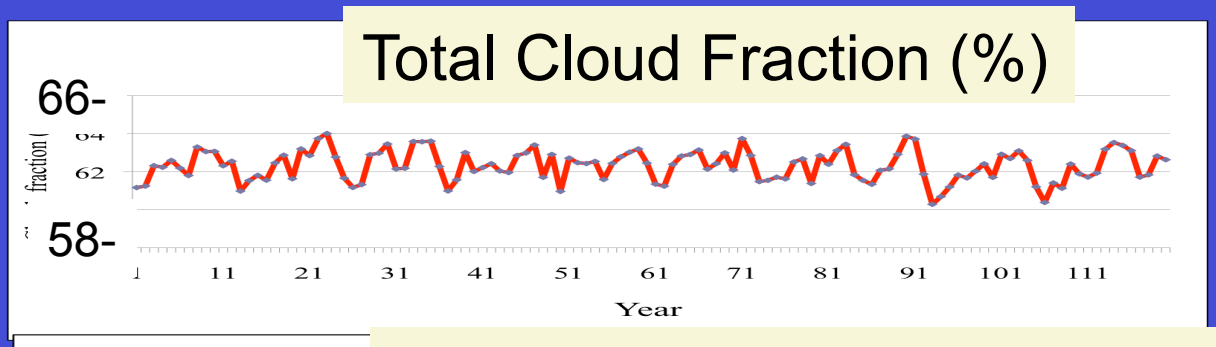


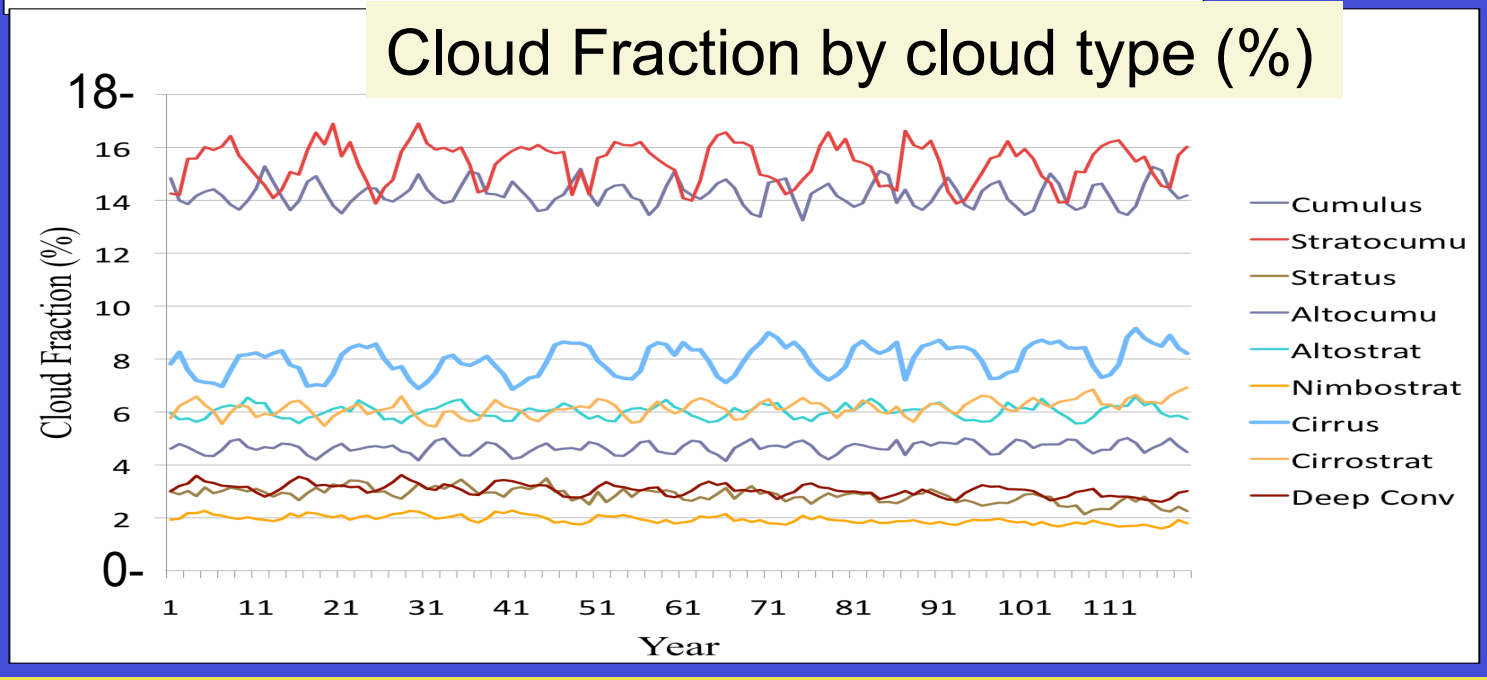

Spatial Resolution
CERES ISCCP-D2like subset and ordering page
Regional (1° x 1° global grid)
North
90
West 0
360 East
-90
South
Satellite
Order MODIS, GEO and Terra/Aqua/GEO daytime cloud properties
Terra-MODIS (3/2000 - 2/2010)
Aqua-MODIS (7/2002 - 2/2010)
GEO (3/2000 - 2/2010)
Terra-MODIS/Aqua-MODIS/GEO (3/2000 - 2/2010)
Time Range
Available Time Range: 3/1/2000 to 2/28/2010
From: 03 - 2000 (MM-YYYY) To: 02 - 2010 (MM-YYYY)
Email Address
david.r.doelling@nasa.gov
By providing your email address you will be informed of any future revisions of your down
Browse Data
Get Data
Add to Cart
(for orders less than 2 GB)
(registration required)
ces
CERES

CERES ISCCP-D2like browse page (Terra-MODIS June 2009)

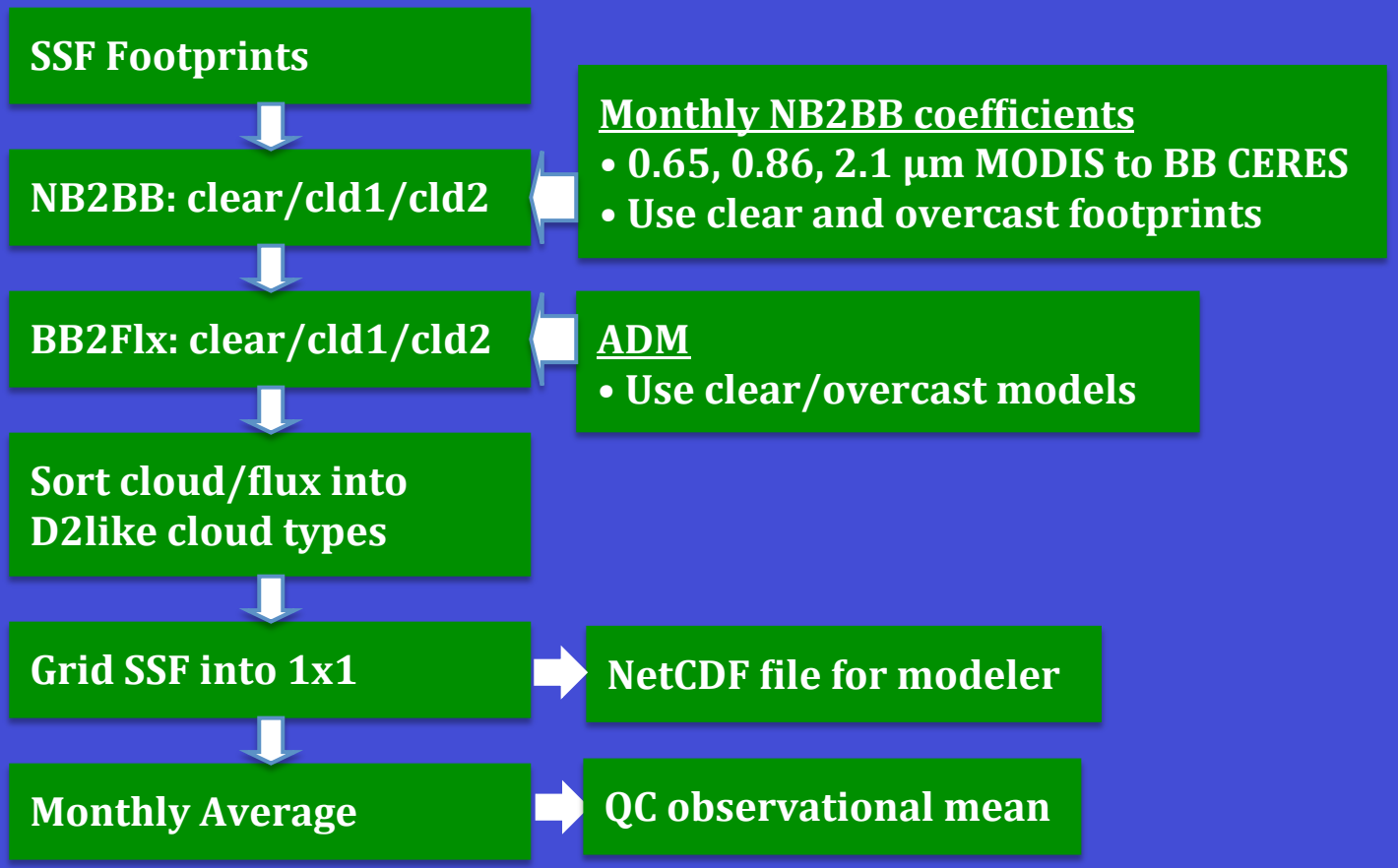


ISCCP-D2like Terra MODIS-day product, 10-years





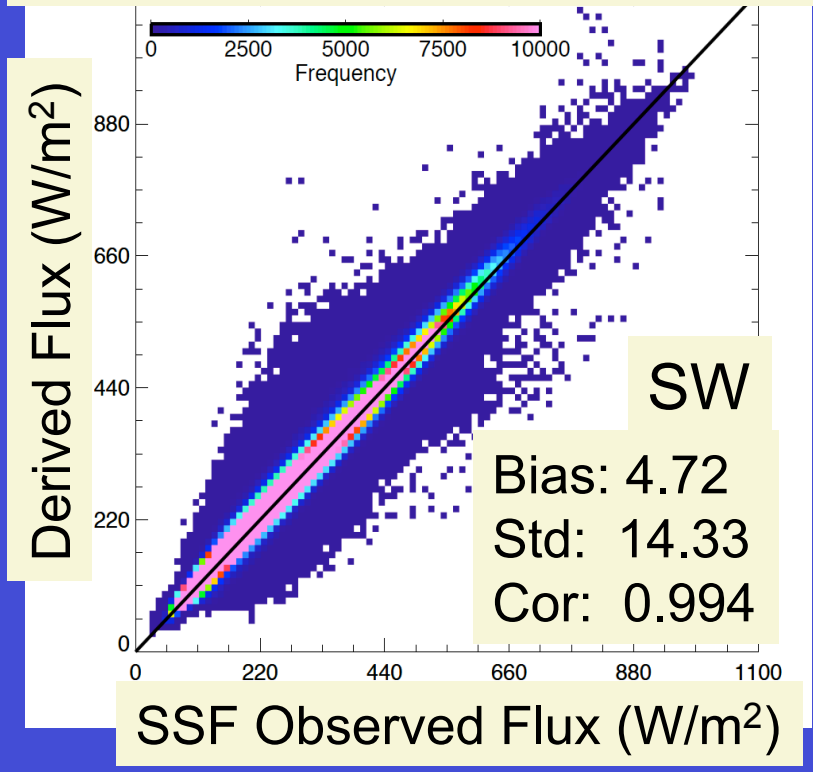
Flux Algorithm

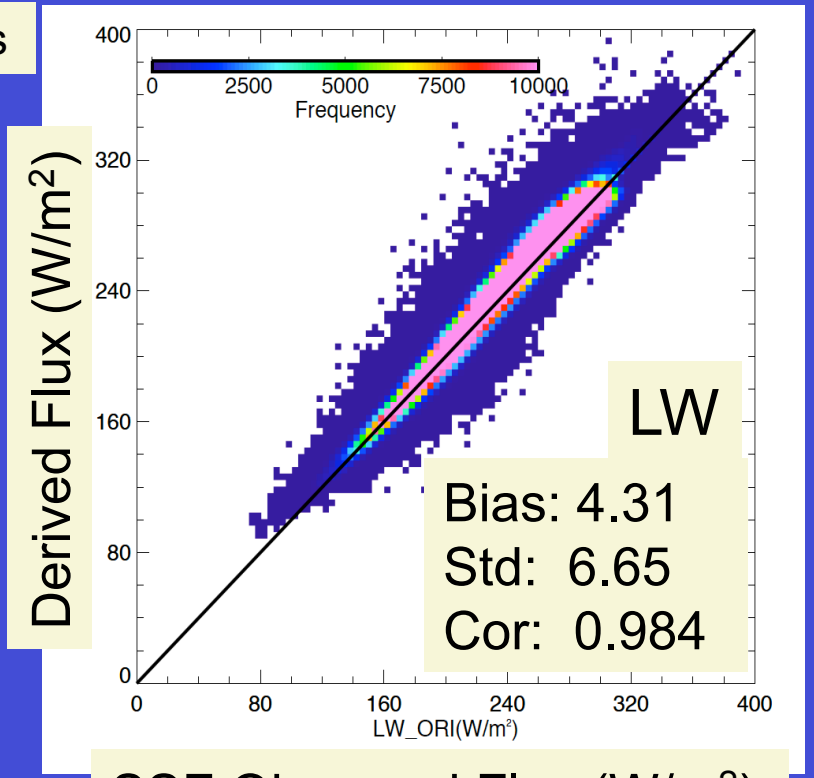


Validation: SW NBtoBB-observed flux, Dec 2002

- Derived NB to BB flux = clear-sky + cloud layers based on clear or overcast NB to BB monthly coefficients

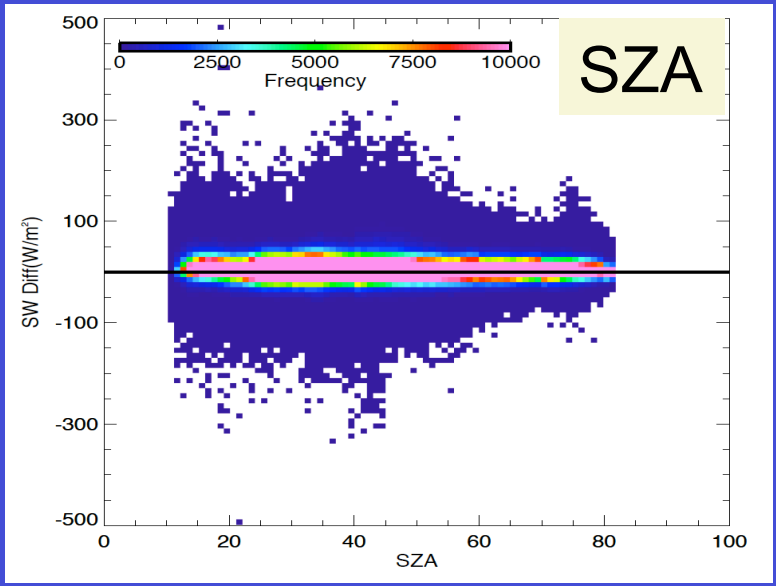
Sample : 10,258,348 partly cloudy footprints

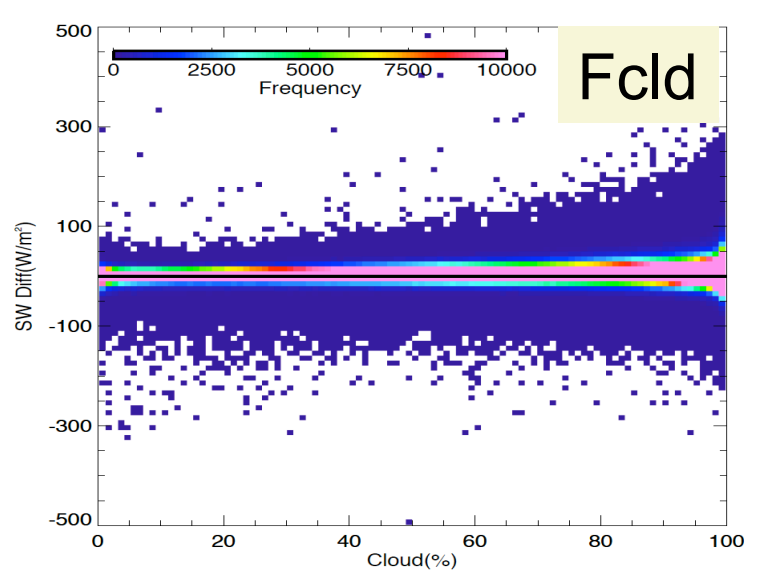


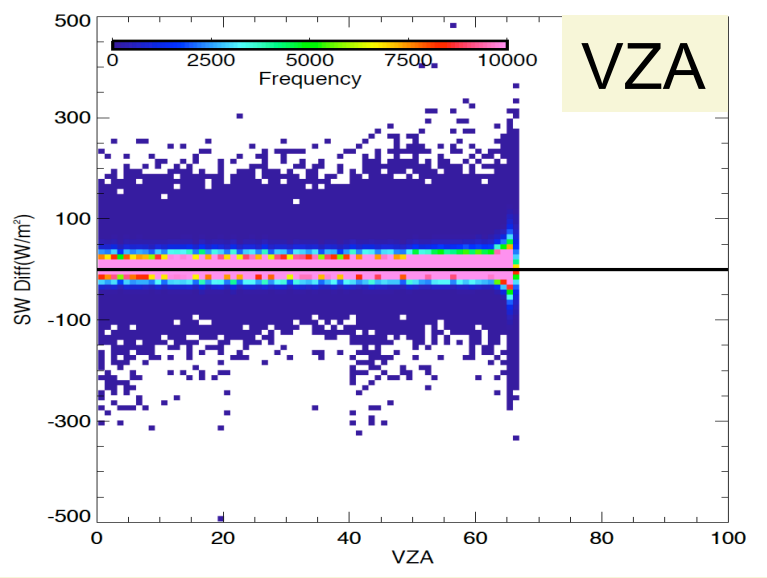


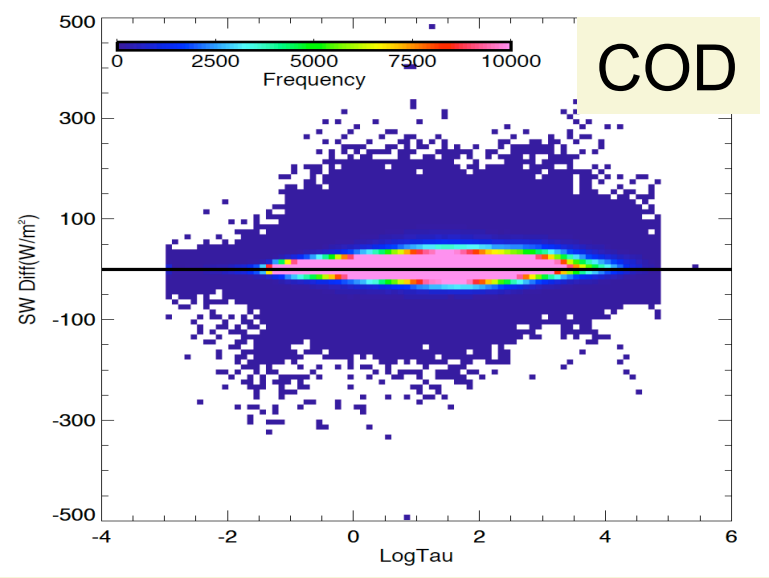
- Production normalizes the footprint derived fluxes to the observed

Validation: SW NBtoBB-observed flux, Dec 2002







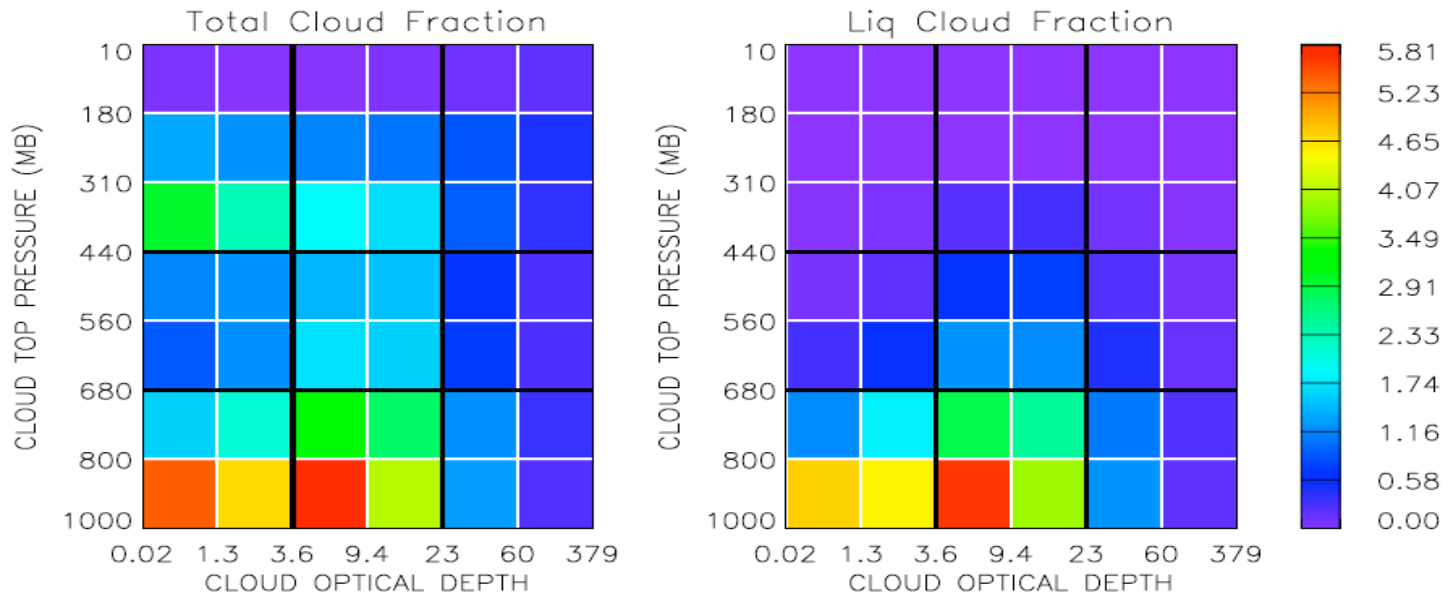


- The NB to BB algorithm is free from SZA, VZA, cloud fraction, & optical dependencies

Flux-by-cloud-type Monthly QC

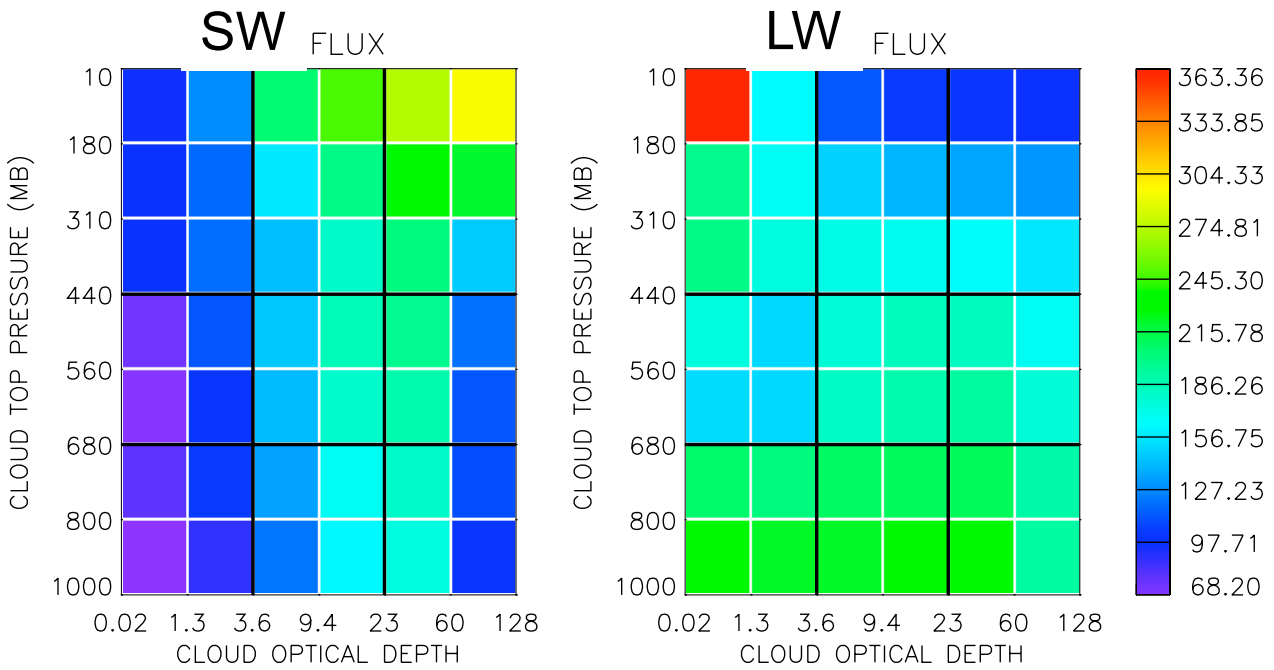
- Derive the SW daily flux from the instantaneous flux assuming constant meteorology using CERES directional model
- Assume no diurnal variation in the LW, use constant flux for the day
- Take all regionally gridded observational daily SW and LW fluxes and compute monthly means
- Bin in appropriate optical depth and pressure layers

Cloud Fraction by type, Terra Day, Dec 2002



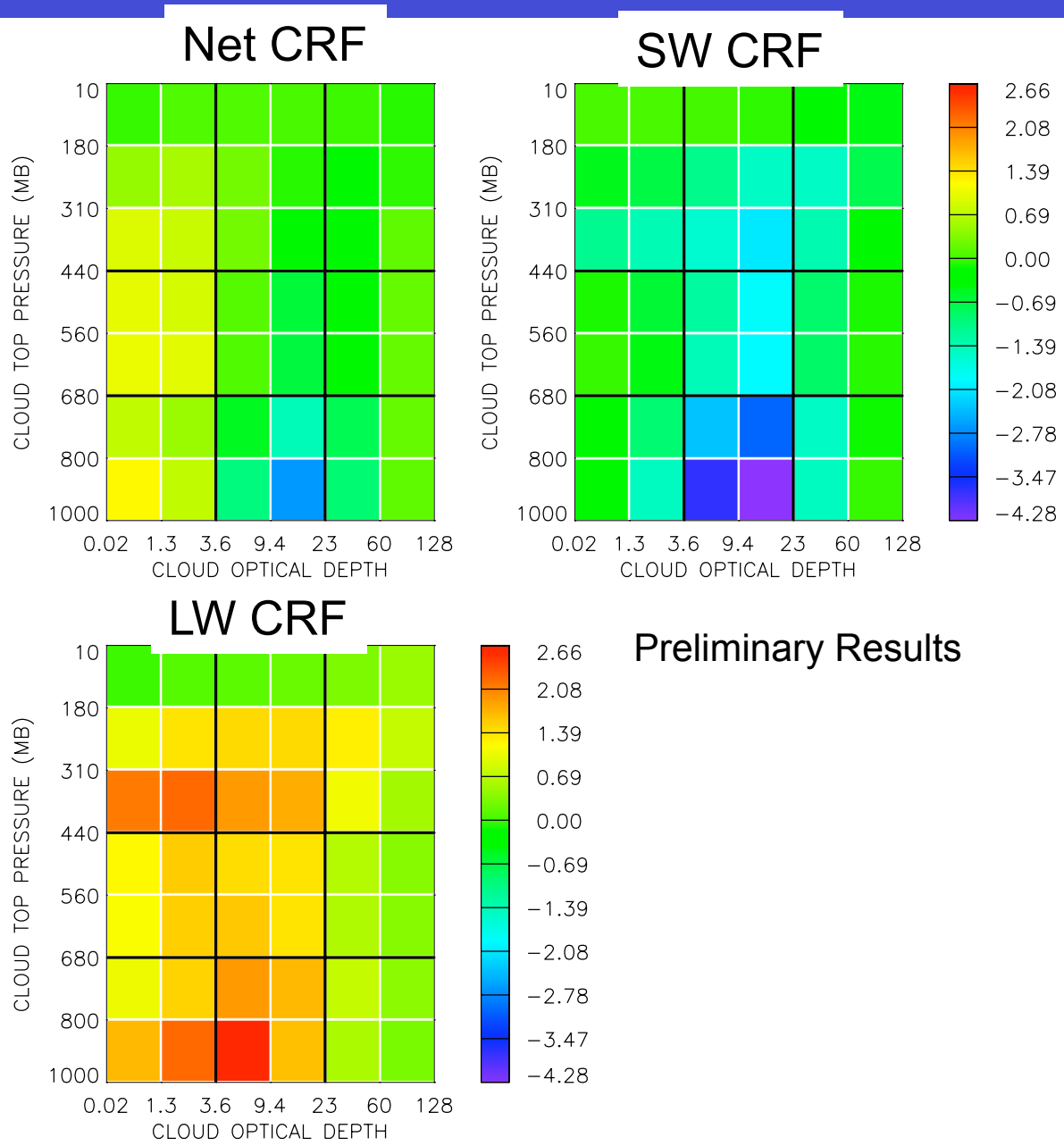
Flux by cloud-type, Terra Day, Dec 2002

Preliminary Results



Clear-sky global SW flux = 53.8
Clear-sky global LW flux = 263.7

FLUX BY CLOUD-TYPE, TERRA DAY, DEC 2002



Preliminary Results

Surface Flux Validation

- Compare Terra constant meteorology, Terra+GEO (SYN Terra), Aqua+GEO (SYN Aqua), Terra+Aqua +GEO (SYN Ed3) Fu-Liou radiative transfer computed surface fluxes to ground site observations over several diurnal 3-hour time increments over the day
- Is GEO adding value?
- Is the Terra/Aqua SYN an improvement over single satellite SYN?

D. Doelling, *NASA LaRC*

D. Rutan, *SSAI*

SW Surface Flux Down (%)

SW Surface Flux Down; Hourly; 2004/07; Bias(RMS) %					
Group	Process/Time	6-9AM	9-12PM	12-3PM	3-6PM
SGP Site	MODIS Only	7(33)	4(21)	1(16)	-3(25)
	SYN Aqua	3(22)	1(16)	1(14)	-2(18)
	SYN Terra	3(22)	1(15)	1(15)	-2(18)
	Terra & Aqua	1(22)	0(15)	-0(14)	-3(19)
DESERT	MODIS Only	-4(15)	0(9)	0(10)	-2(14)
	SYN Aqua	-3(15)	1(9)	1(9)	-2(12)
	SYN Terra	-3(15)	1(9)	1(9)	-1(12)
	Terra & Aqua	-5(16)	-0(9)	-0(9)	-3(13)
BSRN Continental	MODIS Only	1(36)	1(26)	2(23)	2(33)
	SYN Aqua	2(26)	1(20)	2(22)	-1(26)
	SYN Terra	3(25)	2(19)	3(22)	-1(28)
	Terra & Aqua	1(25)	0(19)	0(21)	-2(28)
Island Sites	MODIS Only	6(35)	7(26)	8(25)	5(34)
	SYN Aqua	6(31)	6(22)	9(24)	7(30)
	SYN Terra	7(31)	4(20)	10(24)	8(30)
	Terra & Aqua	6(30)	4(20)	9(23)	7(30)

- Adding GEO improves the RMS error in morning and evening
- Terra/Aqua slightly improves the bias over single satellite

LW Surface Flux Down (%)

LW Surface Flux Down; 2004/07; Bias(RMS) %					
Group	Process/Time	6-9AM	9-12PM	12-3PM	3-6PM
SGP Site	MODIS Only	-2(5)	-2(4)	-3(4)	-2(4)
	SYN Aqua	-2(4)	-3(4)	-3(4)	-2(4)
	SYN Terra	-2(4)	-3(4)	-3(4)	-2(4)
	Terra & Aqua	-2(4)	-3(4)	-3(4)	-2(4)
DESERT	MODIS Only	-6(7)	-8(8)	-7(8)	-5(6)
	SYN Aqua	-6(7)	-7(8)	-6(7)	-4(5)
	SYN Terra	-6(7)	-8(8)	-6(7)	-4(5)
	Terra & Aqua	-6(7)	-8(9)	-7(7)	-5(5)
BSRN Continental	MODIS Only	-3(6)	-3(6)	-3(5)	-3(6)
	SYN Aqua	-2(6)	-3(6)	-3(5)	-2(6)
	SYN Terra	-3(6)	-4(6)	-4(6)	-3(6)
	Terra & Aqua	-3(6)	-4(6)	-3(6)	-3(6)
Island Sites	MODIS Only	-1(3)	-1(3)	-2(3)	-1(3)
	SYN Aqua	-1(2)	-1(2)	-2(3)	-1(3)
	SYN Terra	-1(2)	-1(2)	-2(3)	-1(3)
	Terra & Aqua	-1(2)	-1(2)	-2(3)	-1(3)

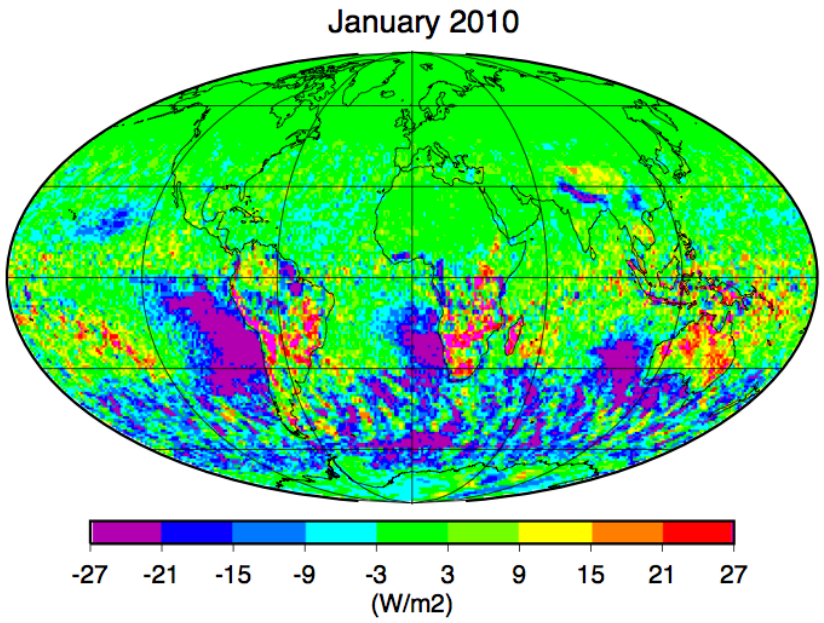
- LW surface flux down is insensitive to cloud input

GEO Narrowband to Broadband

- GEO visible and IR radiances are calibrated against MODIS
- GEO Cloud properties
  - Uses subset of CERES MODIS cloud algorithm based on VIS and IR radiances, need to convert radiances into fluxes
- GEO Narrowband to Broadband radiance conversion
  - First adjust GEO radiance to MODIS using models
  - MODIS equivalent to broadband radiance using model based on coincident MODIS and CERES measurements
- CERES ADMs are used to convert GEO broadband radiances into fluxes
- GEO derived instantaneous SW fluxes are regressed monthly against coincident CERES observed fluxes over a 5°x5° domain
- Normalization of GEO SW flux data stream with CERES mitigated regional biases and functionality with SZA, VZA and cloud amount
- Improve SW regional normalization using 1-hourly GEO

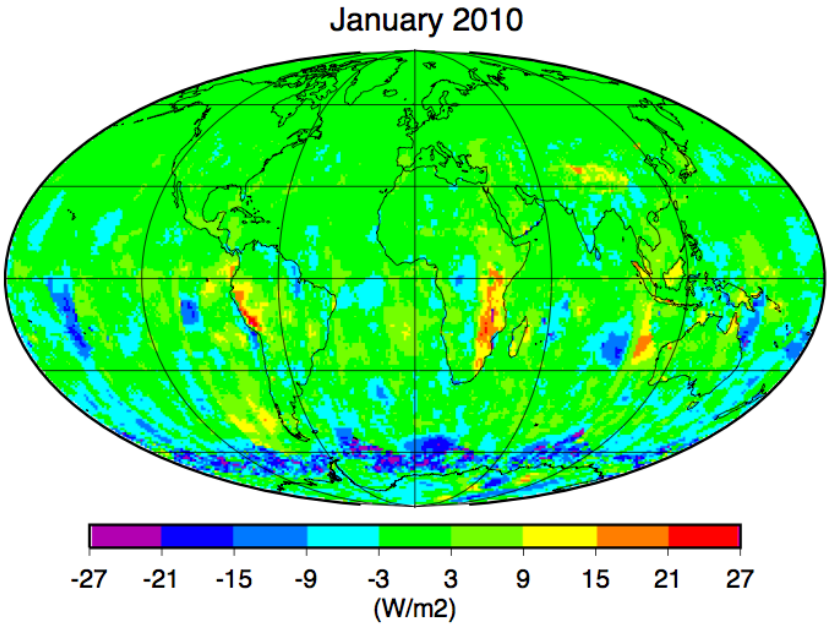
GEO SW regional flux normalization with CERES

Aqua-Terra SSF (nonGEO)



	SYN	SSF	BIAS
Global	102.27	104.25	-1.98

Aqua-Terra SYN (GEO)

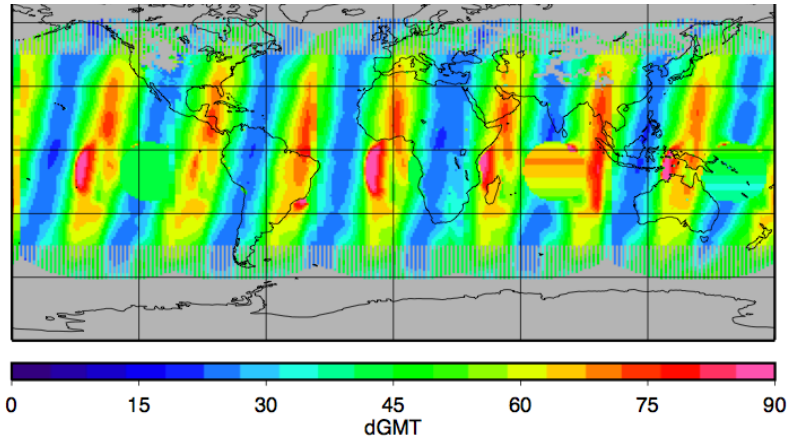


	SYN	SSF	BIAS
Global	104.33	104.85	-0.52

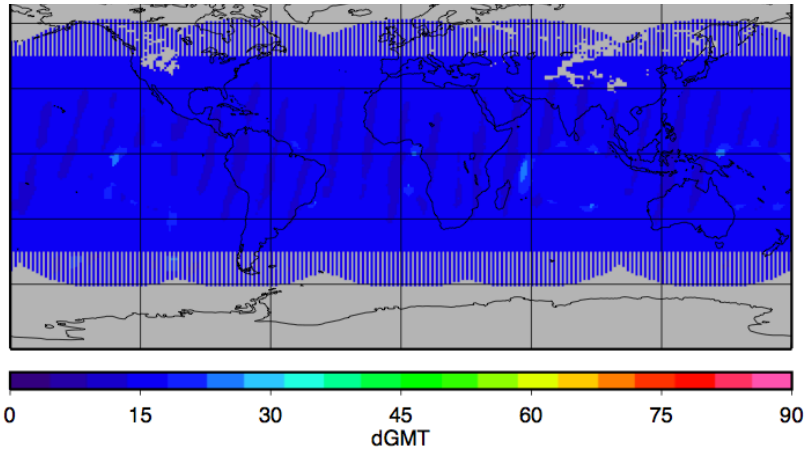
- Expect large nonGEO Aqua-Terra difference based on overpass times
- If GEO derived BB fluxes were perfect there would be no Aqua-Terra difference
- Note the 45° longitude banding, due to GEO SW regional normalization artifact

SW regional normalization, Jan 2010

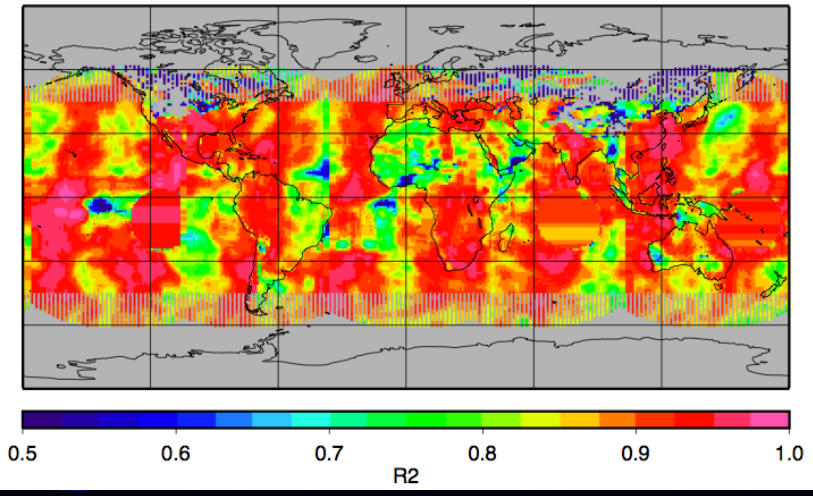
3-hourly GEO
ΔGMT



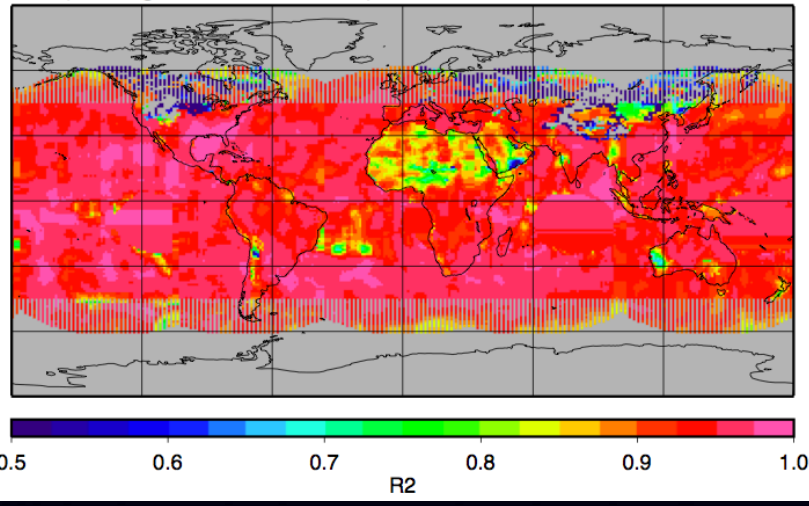
1-hourly GEO
ΔGMT



R^2

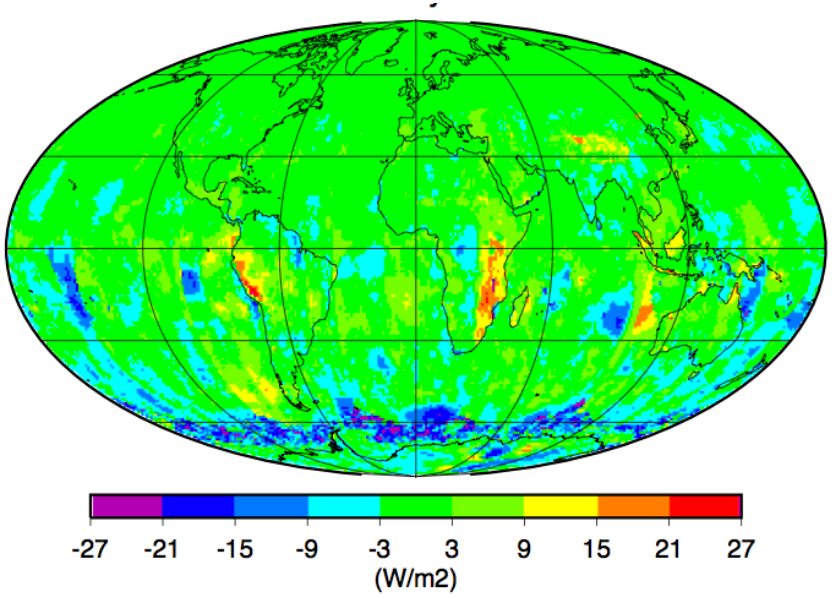


R^2



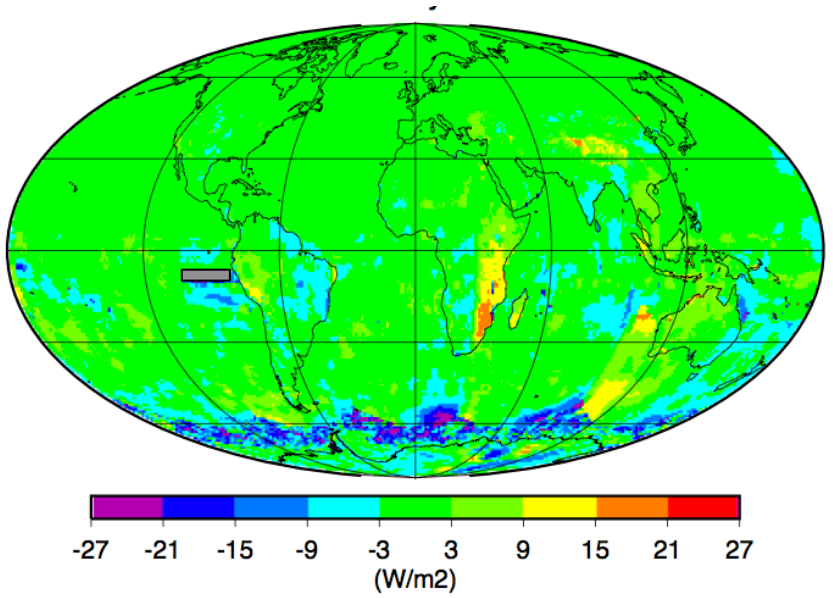
SW regional normalization, Jan 2010

Aqua-Terra 3-hourly GEO



	SYN	SSF	BIAS
Global	104.33	104.85	-0.52

Aqua-Terra 1-hourly GEO



	SYN	SSF	BIAS
Global	104.73	105.34	-0.62

TISA near term goals

- Deliveries since last April 2010
  - TSI Ed3, ISCCP-D2like merge Ed2
- Projected deliveries
  - GEO coefficients valid to Dec 2010
  - SYN and SSF lite Edition2.5b products until Dec 2010
  - EBAF Ed2.5b from Mar00 to Dec 2010, with the SW nonGEO-GEO trend removed
  - Flux_by_cloudtype beta to be tested by Jason Cole and any other volunteers
- Edition4 improvements
  - Finalize GEO coefficients with desert, DCC, spectral corrections, consistency with Terra and Aqua MODIS
  - Quantify 1-hourly GEO over 3-hour GEO derived flux improvements
    - Release in next version of SYN lite product
  - LW angular NB to BB and regional normalization, similar to SW
    - Currently global NB to BB coefficients and instantaneous normalization
  - GEO based land clear-sky maps for improved GEO cloud retrievals
    - Test 5-channel GEO cloud code
- Finish writing CERES TISA paper
  - Finalize GERB results